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NFPA 1981

Standard on
Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services

2002 Edition

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NFPA 1981

Standard on

Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services

2002 Edition

This edition of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services,* was prepared by the Technical Committee on Respiratory Protection and Personal Alarm Equipment, released by the Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment, and acted on by NFPA at its May Association Technical Meeting held May 19–23, 2002, in Minneapolis, MN. It was issued by the Standards Council on July 19, 2002, with an effective date of August 8, 2002, and supersedes all previous editions.

This edition of NFPA 1981 was approved as an American National Standard on July 19, 2002.

Origin and Development of NFPA 1981

The first NFPA document to address fire fighter respiratory protection was NFPA 19B, *Standard on Respiratory Protective Equipment for Fire Fighters.* NFPA 19B was adopted on 17 May 1971 at the Association's Annual Meeting in San Francisco, California. It was developed by the Sectional Committee on Protective Equipment for Fire Fighters of the Technical Committee on Fire Department Equipment. After 1975, the Sectional Committee was removed from the Technical Committee on Fire Department Equipment and made its own technical committee. The main thrust of NFPA 19B was to prohibit filter-type canister masks for fire fighters and permit only self-contained breathing apparatus. NFPA 19B was officially withdrawn by the Association on 19 May 1981 at the Annual Meeting in Dallas, Texas.

NFPA 1981, *Standard on Self-Contained Breathing Apparatus for Fire Fighters,* was adopted at the same meeting to replace NFPA 19B. That first edition of NFPA 1981 essentially specified NIOSH/MSHA-approved SCBA with a minimum rated service life of 30 minutes. Open-circuit SCBA was required to be positive pressure.

The Technical Committee on Protective Equipment for Fire Fighters undertook a complete revision of NFPA 1981 to state performance requirements and appropriate testing procedures designed to simulate various environmental conditions that fire fighters' SCBA can be exposed to during use and storage. These requirements are in addition to the basic NIOSH/MSHA certification requirements, and now NFPA 1981 applies to open-circuit SCBA.

The second edition of NFPA 1981 was completed in March 1986 and adopted by the Association at the 1987 Annual Meeting in Cincinnati, Ohio.

Since the second edition, the name of the Technical Committee was changed to Fire Service Protective Clothing and Equipment, and a standing Subcommittee on Self-Contained Breathing Apparatus was established.

The third edition, 1992, incorporated new requirements for third-party certification and quality control, as well as a new total heat and flame test for the entire apparatus. Other test methods covering facepiece lens abrasion and communications were revised.

The third edition was completed in December 1991 and presented to the Association at the 1992 Annual Meeting in New Orleans, Louisiana.

Since the third edition, the entire project for fire service protective clothing and equipment was reorganized, in January 1995, by the Standards Council. The new project has a Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment and seven technical committees operating within the project. The former standing Subcommittee on Self-Contained Breathing Apparatus was changed into the new Technical Committee on Respiratory Protection and Personal Alarm Equipment.

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The fourth edition incorporated new requirements for surrogate cylinders to replace the actual breathing gas cylinders during the vibration testing to assure a higher level of safety during this rigorous test. A new requirement for redundant end-of-service-time indicators (EOSTI) was added to provide a better level of safety in case of failure of one end-of-service-time indicator.

The fourth edition was presented to the Association membership at the 1997 Annual Meeting in Los Angeles, California on 22 May 1997.

This fifth edition incorporates new requirements for heads-up displays (HUD) that will provide visual information and warnings to SCBA wearers of the status of the SCBA's air supply and, where the HUD is powered by battery, the battery status. These new requirements were in response to fire service requests for providing user-friendly information for the SCBA wearers so that they can better understand their environment and limitations.

Also in response to strong fire service input to the Committee, new requirements are specified for a single universal air connection located in a specific position on all new SCBA certified as compliant with the 2002 edition of NFPA 1981, and existing SCBA that could be upgraded and certified as compliant with the 2002 edition of NFPA 1981. The RIC UAC [RIC stands for Rapid Intervention Company or Crew (sometimes called RIT, Rapid Intervention Team, or FAST Company or Crew) and UAC stands for Universal Air Connection] will permit replenishing the breathing air cylinder of an SCBA user to be replenished from an independent rescue breathing air supply source while the SCBA victim remains trapped or unable to be removed from the hazardous atmosphere. This RIC UAC does not take breathing air from an SCBA being worn by a member of the rescue operation but replenishes the victim's breathing air cylinder from a source of "rescue breathing air" such as a rescue breathing air cylinder or a high-pressure breathing air supply line. The RIC UAC is not a "buddy breathing" device, as it does not permit the sharing of a single SCBA breathing air source between two persons. NIOSH does not permit or certify any "buddy breathing system" that would allow two users to share a single breathing air source. Because NFPA 1981 requires NIOSH certification as a prerequisite to become certified as compliant with NFPA 1981, NFPA cannot permit "buddy breathing systems" as this would be in violation of NIOSH regulations.

The Committee recognizes the support and cooperation of NIOSH in developing the new criteria and expresses its thanks to Richard Metzler, Director of the NIOSH Personal Protection Technical Laboratories, Pittsburgh, Pennsylvania, whose assistance made this new requirement possible and provides increased rescue potential for SCBA users.

The Committee continues to review and revise text for improved clarity and specificity, improved accuracy in testing and test result reporting, and added additional criteria to better evaluate and test the EOSTI.

NFPA has revised the format for all codes and standards, resulting in changes to the chapter order in the 2002 edition. Users of this document will note that chapter, section, and paragraph numbers will not match or correspond to those of previous editions.

This fifth edition was presented to the NFPA membership at the 2002 Annual Meeting in Minneapolis, Minnesota on 19 May 2002.

In Memoriam, 11 September 2001

We pay tribute to the 343 members of FDNY who gave their lives to save civilian victims on 11 September 2001, at the World Trade Center. They are true American heroes in death, but they were also American heroes in life. We will keep them in our memories and in our hearts. They are the embodiment of courage, bravery, and dedication. May they rest in peace.

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Committee Scope: This Committee shall have primary responsibility for documents on the design, performance, testing, and certification of protective clothing and protective equipment manufactured for fire and emergency services organizations and personnel, to protect against exposures encountered during emergency incident operations. This Committee shall also have the primary responsibility for documents on the selection, care, and maintenance of such protective clothing and protective equipment by fire and emergency services organizations and personnel.

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Committee Scope: This Committee shall have primary responsibility for documents on protective equipment that provides respiratory protection for fire fighters or other emergency services responders during incidents involving operations conducted in hazardous or oxygen deficient atmospheres. These operations include the activities of rescue, fire suppression, hazardous materials mitigation, and property conservation where exposures to an oxygen deficient atmosphere or an atmosphere contaminated with harmful particulate, fog, fume, mist, gas, smoke, spray, or vapor will or could occur.

This committee shall also have primary responsibility for documents on personal monitor/alarm/distress devices for responders operating in hazardous atmospheres or in hazard areas at incidents where entrapment, disorientation, or other responder personal emergency could occur.

Additionally, this committee shall have primary responsibility for documents on the selection, care, and maintenance of respiratory and personal alarm equipment by fire and emergency services organizations and personnel.

These lists represent the membership at the time the Committees were balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall specify the minimum requirements for the design, performance, testing, and certification of open-circuit self-contained breathing apparatus (SCBA) and combination open-circuit self-contained breathing apparatus and supplied air respirators (SCBA/SAR) for fire and emergency services personnel.

1.1.2 This standard shall specify the requirements for SCBA as detailed in Section 1.3, Application.

1.1.3 This standard shall not specify requirements for other types of self-contained breathing apparatus.

1.1.4 Nothing herein shall restrict any jurisdiction or manufacturer from exceeding these minimum requirements.

1.2 Purpose.

1.2.1 The purpose of this standard shall be to establish minimum levels of protection for fire and emergency services personnel from immediately dangerous to life and health (IDLH) atmospheres.

1.2.2 The purpose of this standard also shall be to establish requirements to ensure that accessories do not degrade the performance of the SCBA.

1.2.3* Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing performance levels for all respiratory protective situations and IDLH atmospheres to which personnel can be exposed.

1.2.4* This standard shall not be interpreted or used as a detailed manufacturing or purchase specification, but shall be permitted to be referenced in purchase specifications as minimum requirements.

1.3 Application.

1.3.1 This standard shall apply to all open-circuit SCBA and combination SCBA/SARs used by fire and emergency service organizations for respiratory protection of its personnel during operations that include but are not limited to fire fighting, rescue, and hazardous materials where products of combustion, oxygen deficiency, particulates, toxic products, or other IDLH atmospheres do exist or could exist at the incident scene.

1.3.2 This standard shall apply to the design, manufacturing, and certification of new open-circuit SCBA.

1.3.3 This standard shall not apply to open-circuit SCBA manufactured according to previous editions of this standard; however, organizations shall be permitted to have open-circuit SCBA that are certified as compliant with previous editions of this standard and modified to become compliant with this edition of NFPA 1981.

1.3.4 This standard shall not apply to closed-circuit SCBA.

1.3.5 This standard shall not apply to accessories that can be attached to any open-circuit SCBA and combination SCBA/SARs other than as specifically addressed herein.

1.3.6 This standard shall not apply to the use of SCBA and combination SCBA/SARs as these requirements are specified in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program.*

1.4 Units.

1.4.1 In this standard, values for measurement are followed by an equivalent in parentheses, but only the first stated value shall be regarded as the requirement.

1.4.2 Equivalent values in parentheses shall not be considered as the requirement as these values might be approximate.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* 2002 edition.

NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting,* 2000 edition.

2.3 Other Publications.

2.3.1 AATCC Publication. American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics,* 1995.

2.3.2 ANSI Publications. American National Standards Institute, 11 West 42nd Street, 13th floor, New York, NY 10036.

ANSI/CGA G-7.1, *Commodity Specification for Air,* 1989.

ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems,* 1989.

ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations,* 1997.

2.3.3 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117, *Standard Test Method for Salt Spray (Fog) Testing,* 1985.

ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics,* 1988.

ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test),* 1999.

ASTM F 1359, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*, 1999 edition.

2.3.4 EN Publication (CEN). European Committee for Standardization Central Secretariat, rue de Stassart 36, B 1050 Brussels, Belgium.

EN 136, *Respiratory protection devices — Full face masks — Requirements, testing, marking*, 1998.

2.3.5 ISO Publications. International Standards Organization, 1 rue de Varembé, Case Postale 56, CH-1211 Genéve 20, Switzerland.

ISO/IEC Guide 27, *Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity*, 1983.

ISO/IEC 65, *General requirements for bodies operating product certification systems*, 1996.

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, 1999.

ISO 9001, *Quality management systems — requirements,* 2000.

2.3.6 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 42, *Code of Federal Regulations,* Part 84, *Respiratory Protective Devices, Tests for Permissibility,* 8 June 1995.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not included, common usage of the terms shall apply. For the purposes of this standard, the following terms shall have the meanings stated in Section 3.3 unless modified by specific text within the mandatory requirements of this standard. Where terms are not defined in Section 3.3 those terms shall have the ordinarily accepted meanings or the meaning that the text implies. Terms used in the present tense shall include the past and future tense, terms used in the masculine gender shall include the feminine and neuter genders, terms used in the singular shall include the plural, and terms used in the plural shall include the singular.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 Accessory. An item, or items, that are attached to the certified product that are not necessary to meet the requirements of the standard.

3.3.2 Atmosphere-Supplying Respirator. A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere and includes self-contained breathing apparatus (SCBA) and supplied air respirators (SAR). *(See also 3.3.11, Combination SCBA/SAR, 3.3.41, Self-Contained Breathing Apparatus, and 3.3.44, Supplied Air Respirator.)*

3.3.3 Basic Plane. The plane through the centers of the external ear openings and the lower edges of the eye sockets.

3.3.4 Breathing Air. See 3.3.14, Compressed Breathing Air.

3.3.5 Breathing Air Cylinder. The pressure vessel or vessels that are an integral part of the SCBA and that contain the breathing gas supply; can be configured as a single cylinder or other pressure vessel, or as multiple cylinders or pressure vessels.

3.3.6 Breathing Air/Gas Container. See 3.3.5, Breathing Air Cylinder.

3.3.7 Certification/Certified. A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of this standard, authorizes the manufacturer to use a label on listed products that comply with the requirements of this standard, and establishes a follow-up program conducted by the certification organization as a check on the methods the manufacturer uses to determine continued compliance of labeled and listed products with the requirements of this standard. *(See also 3.3.29, NIOSH Certified.)*

3.3.8 Certification Organization. An independent third-party organization that determines product compliance with the requirements of this standard with a labeling/listing/follow-up program.

3.3.9 Char. The formation of a brittle residue when material is exposed to thermal energy.

3.3.10 Closed-Circuit SCBA. A recirculation-type SCBA in which the exhaled gas is rebreathed by the wearer after the carbon dioxide has been removed from the exhalation gas and the oxygen content within the system has been restored from sources such as compressed breathing air, chemical oxygen, and liquid oxygen, or compressed gaseous oxygen.

3.3.11* Combination SCBA/SAR. An atmosphere-supplying respirator that supplies a respirable atmosphere to the user from a combination of two breathing air sources that both are independent of the ambient environment and consists of (1) an open-circuit SCBA certified as compliant with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services*, and having a minimum rated service time of 30 minutes; and (2) having a connection for the attachment of an air line that would provide a continuous supply of breathing air independent of the SCBA breathing air supply. *(See also 3.3.2, Atmosphere-Supplying Respirator, 3.3.41, Self-Contained Breathing Apparatus, and 3.3.44, Supplied Air Respirator.)*

3.3.12 Compliance/Compliant. Meeting or exceeding all applicable requirements of this standard.

3.3.13 Component. Any material, part, or subassembly providing the required protection that is used in the construction of the SCBA.

3.3.14* Compressed Breathing Air. Oxygen or a respirable gas mixture stored in a compressed state and supplied to the user in gaseous form.

3.3.15 Cylinder. See 3.3.5, Breathing Air Cylinder.

3.3.16 Demand SCBA. See 3.3.28, Negative Pressure SCBA.

3.3.17 Drip. To run or fall in drops or blobs.

3.3.18 End-of-Service-Time Indicator (EOSTI). A warning device on an SCBA that warns the user that the end of the service time of the SCBA is approaching.

3.3.19 Fabric Component. Any single or combination of natural or synthetic material(s) that are pliable and that are made by weaving, felting, forming, or knitting.

3.3.20 Facepiece. The component of an SCBA that covers the wearer's nose, mouth, and eyes.

3.3.21 Follow-up Program. The sampling, inspections, tests, or other measures conducted by the certification organization on a periodic basis to determine the continued compliance of listed products that are being produced by the manufacturer to the requirements of this standard.

3.3.22 Gas. An aeriform fluid that is in a gaseous state at standard temperature and pressure.

3.3.23 Haze. Light that is scattered as a result of passing through a transparent object.

3.3.24 Heads Up Display (HUD). Visual display of information and system condition status visible to the SCBA wearer.

3.3.25 Identical SCBA. SCBA that are produced to the same engineering and manufacturing specifications.

3.3.26 Melt. To change from solid to liquid, or become consumed, by action of heat.

3.3.27 Mid-Sagittal Plane. The plane, perpendicular to the basic and coronal planes, that bisects the head symmetrically.

3.3.28 Negative Pressure SCBA. An SCBA in which the pressure inside the facepiece, in relation to the pressure surrounding the outside of the facepiece, is negative during any part of the inhalation or exhalation cycle.

3.3.29* NIOSH Certified. Tested and certified by the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Department of Health and Human Services in accordance with the requirements of 42 CFR 84, Subpart H. *(See also 3.3.7, Certification/Certified.)*

3.3.30 Open-Circuit SCBA. An SCBA in which exhalation is vented to the atmosphere and not rebreathed. There are two types of open-circuit SCBA: negative pressure or demand type, and positive pressure or pressure demand type.

3.3.31 Pink Noise. Noise that contains constant energy per octave band.

3.3.32 Positive Pressure SCBA. An SCBA in which the pressure inside the facepiece, in relation to the pressure surrounding the outside of the facepiece, is positive during both inhalation and exhalation.

3.3.33 Pressure Demand SCBA. See 3.3.32, Positive Pressure SCBA.

3.3.34* Product Label. A label or marking affixed to the SCBA by the manufacturer containing general information, care, maintenance, or similar data. *(See also 3.2.3, Labeled.)*

3.3.35 Rapid Intervention Crew/Company Universal Air Connection System (RIC UAC). A system that allows emergency replenishment of breathing air to the SCBA of disabled or entrapped fire or emergency services personnel.

3.3.36 Rated Service Time. The period of time, stated on the SCBA's NIOSH certification label, that the SCBA supplied air to the breathing machine when tested to 42 CFR 84, Subpart H.

3.3.37 RIC. Abbreviation for the term "Rapid Intervention Crew/Company."

3.3.38 SAR. An abbreviation for supplied air respirator. *(See 3.3.44, Supplied Air Respirator.)*

3.3.39 SCBA. An abbreviation for self-contained breathing apparatus. For the purposes of this standard, where this abbreviation is used without any qualifier, it indicates only open-circuit self-contained breathing apparatus and combination SCBA/SARs. *(See 3.3.11, Combination SCBA/SAR, and 3.3.41, Self-Contained Breathing Apparatus.)*

3.3.40 SCBA/SAR. An abbreviation for combination open-circuit SCBA and supplied air respirator. *(See 3.3.11, Combination SCBA/SAR, 3.3.41, Self-Contained Breathing Apparatus, and 3.3.44, Supplied Air Respirator.)*

3.3.41 Self-Contained Breathing Apparatus (SCBA). An atmosphere-supplying respirator that supplies a respirable air atmosphere to the user from a breathing air source that is independent of the ambient environment and designed to be carried by the user. For the purposes of this standard, where this term is used without any qualifier, it indicates only open-circuit self-contained breathing apparatus or combination SCBA/SARs. For the purposes of this standard, combination SCBA/SARs are encompassed by the terms self-contained breathing apparatus or SCBA. *(See also 3.3.2, Atmosphere-Supplying Respirator, 3.3.11, Combination SCBA/SAR, and 3.3.44, Supplied Air Respirator.)*

3.3.42 Service Life. The period for which a certified product is useful before retirement.

3.3.43 Service Time. See 3.3.36, Rated Service Time.

3.3.44 Supplied Air Respirator. An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user. Also known as an "airline respirator."

3.3.45 UAC. Abbreviation for the term "Universal Air Connection." Also known as: RIC UAC.

3.3.46 Universal Air Connection (UAC). The male fitting, affixed to the SCBA, and the female fitting, affixed to the filling hose, to provide emergency replenishment of breathing air to an SCBA breathing air cylinder. Also known as Rapid Intervention Crew/Company Universal Air Connection.

Chapter 4 Certification

4.1 General.

4.1.1 The process for certification of SCBA as being compliant with NFPA 1981 shall meet the requirements of Section 4.1, General; Section 4.2, Certification Program; Section 4.3 Inspection and Testing; Section 4.4, Recertification; Section 4.5, ISO Registration for Manufacturers; Section 4.6, Hazards Involving Compliant Product; Section 4.7, Manufacturers' Investigation of Complaints and Returns; and Section 4.8, Manufacturers' Safety Alert and Product Recall Systems.

4.1.2 Prior to certification of SCBA to the requirements of this standard, SCBA shall be NIOSH certified.

4.1.2.1 SCBA shall have NIOSH certification as positive pressure.

4.1.2.2* SCBA shall have a NIOSH certified rated service time of at least 30 minutes.

4.1.2.3 SCBA that are NIOSH certified as positive pressure but capable of supplying air to the user in a negative pressure demand-type mode shall NOT be certified to this standard.

4.1.3 All SCBA that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified. This certification shall be in addition to, and shall not be construed to be the same as, the NIOSH certification as specifically defined in 3.3.29.

4.1.4 All certification shall be performed by a certification organization that meets at least the requirements specified in Section 4.2, Certification Program, and that is accredited for personal protective equipment in accordance with ISO/IEC 65, *General requirements for bodies operating product certification systems.*

4.1.5 Manufacturers shall not claim compliance with a portion(s) or segment(s) of the requirements of this standard and shall not use the name or identification of this standard, NFPA 1981, in any statements about their respective product(s) unless the product(s) is certified as compliant to this standard.

4.1.6 All compliant SCBA shall be labeled and listed.

4.1.7 All compliant SCBA shall also have a product label that meets the requirements specified in Chapter 5.

4.1.8 The certification organization's label, symbol, or identifying mark shall be attached to the product label, shall be part of the product label, or shall be immediately adjacent to the product label.

4.1.9 The certification organization shall not certify any SCBA to the 1997 edition of this standard on or after 1 March 2003.

4.1.10 The certification organization shall not permit any manufacturer to label any SCBA as compliant with the 1997 edition of this standard on or after 1 March 2003.

4.1.11 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 1997 edition of this standard from all SCBA that are under the control of the manufacturer on 1 March 2003. The certification organization shall verify this action is taken.

4.2 Certification Program.

4.2.1* The certification organization shall not be owned or controlled by manufacturers or vendors of the product being certified.

4.2.2 The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

4.2.3 The certification organization shall be accredited for personal protective equipment in accordance with ISO/IEC Guide 65, *General requirements for bodies operating product certification systems.*

4.2.4 The certification organization shall refuse to certify products to this standard that do not comply with all applicable requirements of this standard.

4.2.5* The contractual provisions between the certification organization and the manufacturer shall specify that certification is contingent on compliance with all applicable requirements of this standard.

4.2.5.1 The certification organization shall not offer or confer any conditional, temporary, or partial certifications.

4.2.5.2 Manufacturers shall not be authorized to use any label or reference to the certification organization on products that are not compliant with all applicable requirements of this standard.

4.2.6* The certification organization shall have laboratory facilities and equipment available for conducting proper tests to determine product compliance.

4.2.6.1 The certification organization laboratory facilities shall have a program in place and functioning for calibration of all instruments, and procedures shall be in use to ensure proper control of all testing.

4.2.6.2 The certification organization laboratory facilities shall follow good practice regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

4.2.7 The certification organization shall require the manufacturer to establish and maintain a quality assurance program that meets the requirements of Section 4.5, ISO Registration for Manufacturers.

4.2.7.1 The certification organization shall require the manufacturer to have a safety alert and product recall system as part of the manufacturer's quality assurance program.

4.2.7.2 The certification organization shall audit the manufacturer's quality assurance program to ensure that the quality assurance program provides continued product compliance with this standard.

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4.2.8 The certification organization and the manufacturer shall evaluate any changes affecting the form, fit, or function of the compliant product to determine its continued certification to this standard.

4.2.9* The certification organization shall have a follow-up inspection program of the manufacturing facilities of the compliant product, with at least two random and unannounced visits per 12-month period.

4.2.9.1 As part of the follow-up inspection program, the certification organization shall select sample product at random from the manufacturer's production line, from the manufacturer's in-house stock, or from the open market.

4.2.9.2 Sample product shall be inspected and tested by the certification organization to verify the product's continued compliance.

4.2.10 The certification organization shall have in place a series of procedures, as specified in Section 4.6, Hazards Involving Compliant Product, that address report(s) of situation(s) in which a compliant product is subsequently found to be hazardous.

4.2.11 The certification organization's operating procedures shall provide a mechanism for the manufacturer to appeal decisions. The procedures shall include the presentation of information from both sides of a controversy to a designated appeals panel.

4.2.12 The certification organization shall be in a position to use legal means to protect the integrity of its name and label. The name and label shall be registered and legally defended.

4.3* Inspection and Testing.

4.3.1 For both certification and recertification of SCBA, the certification organization shall conduct both inspection and testing specified in this section.

4.3.2 All inspections, evaluations, conditioning, and testing for certification shall be conducted by the certification organization or a facility accredited by the certification organization for inspections, evaluations, conditioning, and testing in accordance with all requirements pertaining to testing laboratories in ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories.*

4.3.3 All inspections, evaluations, conditioning, and testing conducted by a product manufacturer shall not be used in the certification or recertification process unless the facility for inspections, evaluations, conditioning, or testing has been accredited by the certification organization in accordance with all requirements pertaining to testing laboratories in ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories.*

4.3.4 Sampling levels for testing and inspection shall be established by the certification organization and the manufacturer to ensure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified to this standard are compliant, unless such sampling levels are specified herein. Information about sampling levels shall be provided to the purchaser upon request.

4.3.5 SCBA and SCBA components shall be subjected to the tests specified in Table 4.3.5 for each series.

4.3.6 SCBA shall be initially tested for certification and shall meet the performance requirements of three separate test series of Categories A, B, C, D, and E, as specified in Table 4.3.5. All tests within Categories A, B, C, D, and E shall be conducted in the order specified and are designed as cumulative damage tests.

4.3.7 SCBA fabric, thread, and lens components shall be initially tested for certification and shall meet the performance requirements of one test series of Category F, as specified in Table 4.3.5. SCBA component testing in Category F shall be conducted on test specimens as specified in each respective test method.

4.3.8 SCBA shall be initially tested for certification and shall meet the performance requirements of one test series for Category G, as specified in Table 4.3.5 for each EOSTI identified by the product manufacturer. Additional SCBA shall be permitted to be used, where necessary, to conduct all of the Category G tests.

4.3.9 After certification, compliant SCBA and components of compliant SCBA shall be tested annually within 12 months of previous tests and shall meet the performance requirements of one test series of Categories A, B, C, D, E, F, and G, as specified in Table 4.3.5.

4.3.10 A minimum of six identical SCBA that are to be certified to this standard shall be selected from the manufacturer's production.

4.3.11 The first SCBA shall be subjected to the tests listed in Category A, the second SCBA shall be subjected to the tests listed in Category B, the third SCBA shall be subjected to the tests in Category C, the fourth SCBA shall be subjected to the tests in Category D, the fifth SCBA shall be subjected to the tests in Category E, and the sixth SCBA, at a minimum, shall be subjected to the tests in Category G, as shown in Table 4.3.5. Additional SCBA shall be permitted to be used, where necessary, to conduct all of the Category G tests.

4.3.12 Components from SCBA that are to be certified to this standard shall be subjected to the tests specified in Category F of Table 4.3.5. SCBA component testing in Category F shall be conducted on test specimens as specified in each respective test method.

4.3.13 The requirement specified in 4.3.9 shall be waived every fifth year when the testing required by 4.3.14 is conducted.

4.3.14 Compliant SCBA shall be tested and shall meet the performance requirements of three separate test series of Categories A, B, C, D, and E as specified in Table 4.3.5, every fifth year from the date of the initial certification testing specified in 4.3.6.

4.3.15 SCBA fabric, thread, and lens components shall be tested and shall meet the performance requirements of one test series of Category F, as specified in Table 4.3.5, every fifth year from the date of the initial certification testing specified in 4.3.7. SCBA component testing in Category F shall be conducted on test specimens as specified in each respective test method.

4.3.16 Compliant SCBA shall be tested and shall meet the performance requirements of one test series for Category G, as specified in Table 4.3.5, for each EOSTI identified by the product manufacturer, every fifth year from the date of the initial certification testing specified in 4.3.8. Additional SCBA shall be permitted to be used, where necessary, to conduct all of the Category G tests.

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Table 4.3.5 Test Series

Test Order	Category A (SCBA #1)	Category B (SCBA #2)	Category C (SCBA #3)	Category D (SCBA #4)	Category E (SCBA #5)	Category F (Component Tests)	Category G (Additional SCBA as required)
1	Air flow *(Section 8.1)*	Air flow *(Section 8.1)*	Air flow *(Section 8.1)*	Air flow *(Section 8.1)*	HUD visibility performance *(Sections 8.18, 8.19, and 8.20)*	Fabric flame resistance *(Section 8.4)*	EOSTI independent activation *(Section 8.13)*
2	Facepiece carbon dioxide content *(Section 8.12)*	RIC UAC cylinder refill breathing performance *(Section 8.21)*	Vibration resistance *(Section 8.3)*	Heat and flame resistance *(Section 8.11)*	HUD low-battery visual alert signal test *(Section 8.16)*	Fabric heat resistance *(Section 8.5)*	EOSTI recognition performance *(Section 8.14)*
3	Communications performance *(Section 8.10)*	RIC UAC system fill rate performance *(Section 8.22)*			HUD liquid splash resistance *(Section 8.17)*	Thread heat resistance *(Section 8.6)*	
4	Environmental temperature *(Section 8.2)*	Accelerated corrosion resistance *(Section 8.7)*			Wiring connection performance *(Section 8.15)*	Facepiece lens abrasion resistance *(Section 8.9)*	
5	Particulate resistance *(Section 8.8)*						

4.3.17 The certification organization shall not allow any modifications, pretreatment, conditioning, or other such special processes of the product or any product component prior to the product's submission for evaluation and testing by the certification organization.

4.3.17.1 The certification organization shall accept from the manufacturer for evaluation and testing for certification only product or product components that are the same in every respect to the actual final product or product component.

4.3.17.2 The certification organization shall not allow the substitution, repair, or modification, other than as specifically permitted herein, of any product or any product component during testing.

4.3.18 No adjustment, repair, or replacement of parts shall be permitted to any SCBA being tested in accordance with this standard; however, breathing air cylinders shall be permitted to be filled as required.

4.3.19 After completion of these tests for a specific model SCBA or its variant, only those tests on other similar SCBA models or variants shall be required where, in the determination of the certification organization, the SCBA's test results can be affected by any components or accessories that are different from those on the original SCBA tested.

4.3.20 Any modifications made to an SCBA, or any accessories provided for an SCBA, by the SCBA manufacturer after certification shall require the retesting and meeting of the performance requirements of all those individual tests that the certification organization determines could be affected by such changes. This retesting shall be conducted before the modified SCBA is certified as being compliant with this standard.

4.3.21 Inspection and evaluation by the certification organization for determining compliance with the design requirements specified in Chapter 6 shall be performed on whole and complete products unless otherwise specified within this standard.

4.3.22 The certification organization shall report on the compliance of SCBA to each design requirement specified in Chapter 6.

4.3.23 Inspection by the certification organization shall include a review of all product labels to ensure that all required label attachments, compliance statements, certification statements, and other information are at least as specified in Section 5.1, Product Label Requirements.

4.3.24 Inspection by the certification organization shall include a review of any graphic representations used on product labels, as permitted by 5.1.5, to ensure that the symbols are consistent with the worded statements, readily understood, and clearly communicate the intended message.

4.3.25 Inspection by the certification organization shall include a review of the user information required by Section 5.2, User Information, to ensure that the information has been developed and is available.

4.4 Recertification.

4.4.1 All SCBA models that are labeled as being compliant with this standard shall undergo recertification on an annual basis.

4.4.2 Recertification shall include inspection and evaluation to all design requirements and testing to all performance requirements as required by 4.3.9 and 4.3.21 on all manufacturer models and components.

4.4.3 The manufacturer shall maintain all design and performance inspection and test data from the certification organization used in the recertification of manufacturer models and components and shall provide such data, upon request, to the purchaser or authority having jurisdiction.

4.5 ISO Registration for Manufacturers.

4.5.1 The manufacturer shall provide and operate a quality assurance program that meets the requirements of this section and that includes a safety alert and product recall system as specified in Section 4.8, Manufacturers' Safety Alert and Product Recall Systems.

4.5.2 The manufacturer shall be registered to ISO 9001, *Quality management systems — requirements.*

4.6 Hazards Involving Compliant Product.

4.6.1* The certification organization shall establish procedures to be followed where situation(s) are reported in which a compliant product is subsequently found to be hazardous. These procedures shall comply with the provisions of ISO/IEC Guide 27, *Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity*, and as modified herein.

4.6.2* Where a report of a hazard involved with a compliant product is received by the certification organization, the validity of the report shall be investigated.

4.6.3 With respect to a compliant product, a hazard shall be a condition, or create a situation, that results in exposing life, limb, or property to an imminently dangerous or dangerous condition.

4.6.4 Where a specific hazard is identified, the determination of the appropriate action for the certification organization and the manufacturer to undertake shall take into consideration the severity of the hazard and its consequences to the safety and health of users.

4.6.5 Where it is established that a hazard is involved with a compliant product, the certification organization shall determine the scope of the hazard including products, model numbers, serial numbers, factory production facilities, production runs, and quantities involved.

4.6.6 The certification organization's investigation shall include, but not be limited to, the extent and scope of the problem as it might apply to other compliant product or compliant product components manufactured by other manufacturers or certified by other certification organizations.

4.6.7 The certification organization shall also investigate reports of a hazard where compliant product is gaining widespread use in applications not foreseen when the standard was written, such applications in turn being ones for which the product was not certified, and no specific scope of application has been provided in the standard, and no limiting scope of application was provided by the manufacturer in written material accompanying the compliant product at the point of sale.

4.6.8 The certification organization shall require the manufacturer of the compliant product, or the manufacturer of the compliant product component if applicable, to assist the certification organization in the investigation and to conduct its own investigation as specified in Section 4.7, Manufacturers' Investigation of Complaints and Returns.

4.6.9 Where the facts indicating a need for corrective action are conclusive and the certification organization's appeal procedures referenced in 4.2.11 have been followed, the certification organization shall initiate corrective action immediately, provided there is a manufacturer to be held responsible for such action.

4.6.10 Where the facts are conclusive and corrective action is indicated, but there is no manufacturer to be held responsible, such as when the manufacturer is out of business or the manufacturer is bankrupt, the certification organization shall immediately notify relevant governmental and regulatory agencies and issue a notice to the user community about the hazard.

4.6.11* Where the facts are conclusive and corrective action is indicated, the certification organization shall take one or more of the following corrective actions:

(1) Parties authorized and responsible for issuing a safety alert shall be notified when, in the opinion of the certification organization, such a safety alert is necessary to inform the users.
(2) Parties authorized and responsible for issuing a product recall shall be notified when, in the opinion of the certification organization, such a recall is necessary to protect the users.
(3) The mark of certification shall be removed from the product.
(4) Where a hazardous condition exists and it is not practical to implement (1), (2), or (3) or the responsible parties refuse to take corrective action, the certification organization shall notify relevant governmental and regulatory agencies and issue a notice to the user community about the hazard.

4.6.12 The certification organization shall provide a report to the organization or individual identifying the reported hazardous condition and notify them of the corrective action indicated, or that no corrective action is indicated.

4.6.13* Where a change to an NFPA standard(s) is felt to be necessary, the certification organization shall also provide a copy of the report and indicated corrective actions to the NFPA, and shall also submit either a Public Proposal for a proposed change to the next revision of the applicable standard, or a proposed Temporary Interim Amendment (TIA) to the current edition of the applicable standard.

4.7 Manufacturers' Investigation of Complaints and Returns.

4.7.1 Manufacturers shall provide corrective action in accordance with ISO 9001, *Quality management systems — requirements*, for investigating written complaints and returned products.

4.7.2 Manufacturers' records of returns and complaints related to safety issues shall be retained for at least 5 years.

4.7.3 Where the manufacturer discovers, during the review of specific returns or complaints, that a compliant product or compliant product component can constitute a potential safety risk to end users and is possibly subject to a safety alert or product recall, the manufacturer shall immediately contact

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the certification organization and provide all information about their review to assist the certification organization with their investigation.

4.8 Manufacturers' Safety Alert and Product Recall Systems.

4.8.1 Manufacturers shall establish a written safety alert system and a written product recall system that describes the procedures to be used in the event that it decides, or is directed by the certification organization, to either issue a safety alert or to conduct a product recall.

4.8.2 The manufacturers' safety alert and product recall systems shall provide the following:

(1) The establishment of a coordinator and responsibilities by the manufacturer for the handling of safety alerts and product recalls
(2) A method of notifying all dealers, distributors, purchasers, users, and the NFPA about the safety alert or product recall that can be initiated within a one-week period following the manufacturer's decision to issue a safety alert or to conduct a product recall, or after the manufacturer has been directed by the certification organization to issue a safety alert or conduct a product recall
(3) Techniques for communicating accurately and understandably the nature of the safety alert or product recall and, in particular, the specific hazard or safety issue found to exist
(4) Procedures for removing product that is recalled and for documenting the effectiveness of the product recall
(5) A plan for either repairing, or replacing, or compensating purchasers for returned product.

Chapter 5 Labeling and Information

5.1 Product Label Requirements.

5.1.1 In addition to the NIOSH certification label, each SCBA shall have a product label permanently and conspicuously attached to the SCBA.

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5.1.2 Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label; however, all label pieces comprising the product label shall be located adjacent to each other.

5.1.3 The certification organization's label, symbol, or identifying mark shall be attached to the product label or be part of the product label and shall be placed in a conspicuous location. All letters shall be at least 2.5 mm ($\frac{3}{32}$ in.) in height and the label, symbol, or identifying mark shall be at least 6 mm ($\frac{15}{64}$ in.) in height.

5.1.4 All worded portions of the required product label shall be at least in English.

5.1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

5.1.6 The following compliance statement shall be legibly printed on the product label, and all letters and numbers shall be at least 2 mm in height:

> "THIS SCBA MEETS THE REQUIREMENTS OF NFPA 1981, *STANDARD ON OPEN-CIRCUIT SELF-CONTAINED BREATHING APPARATUS FOR FIRE AND EMERGENCY SERVICES,* 2002 EDITION."

5.1.7 SCBA components, as listed on the NIOSH certification labels, shall be marked directly on the component with either the lot number, serial number, or year and month of manufacture.

5.2 User Information.

5.2.1 The SCBA manufacturer shall provide with each SCBA at least the training material and user instructions specified within this section.

5.2.2 Upon request at the time of purchase, the manufacturer shall provide to the purchaser an information sheet with each SCBA that documents at least the following:

(1) Manufacturing performance tests conducted at time of manufacture and the results
(2) Date of manufacture
(3) Model number
(4) Serial number
(5) Lot number, if applicable
(6) Hydrostatic test dates and results, if applicable

5.2.3 Information or training materials regarding pre-use shall be provided at least on the following areas:

(1) Safety considerations
(2) Limitations of use
(3) Charging breathing gas cylinders
(4) Breathing gas quality
(5) Marking recommendations and restrictions
(6) Warranty information
(7) Recommended storage practices
(8) Mounting on/in vehicles or fire apparatus

5.2.4 Information or training materials regarding periodic inspections shall be provided at least on inspection frequency and details.

5.2.5 Information or training materials regarding donning and doffing shall be provided at least on the following areas:

(1) Donning and doffing procedures
(2) Adjustment procedures
(3) Interface issues

5.2.6 Information or training materials regarding use shall be provided at least on the following areas:

(1) Pre-use checks
(2) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*
(3) Recharging breathing gas cylinders

5.2.7* Information or training materials regarding periodic maintenance and cleaning shall be provided at least on the following areas:

(1) Cleaning instructions and precautions
(2) Disinfecting procedures
(3) Maintenance frequency and details
(4) Methods of repair, where applicable
(5) Low-battery signals and battery replacement, where applicable

5.2.8 Information or training materials regarding retirement shall be provided at least on replacement/retirement considerations.

5.2.9 The manufacturer shall provide the manufacturer's specified component service life for composite breathing air cylinders and for all elastomeric components of the SCBA. This data shall be included at least in the maintenance information provided to the users.

Chapter 6 Design Requirements

6.1 General.

6.1.1 SCBA shall have at least the applicable design requirements specified in this chapter where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

6.1.2 All SCBA shall be equipped with a full facepiece that covers, as a minimum, the wearer's eyes, nose, and mouth.

6.1.3 All electric circuits integral to an SCBA, or to any SCBA accessories, shall be certified to the requirements for Class I, Division I hazardous locations specified in ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations.*

6.1.4 All hardware, brackets, and snaps or other fasteners of SCBA or any accessories shall be free of rough spots, burrs, or sharp edges.

6.2 End-of-Service-Time Indicator (EOSTI).

6.2.1 All SCBA shall be equipped with a minimum of two independent EOSTI.

6.2.2 Each EOSTI shall be activated with no additional procedures than those required to activate the SCBA breathing system.

6.2.3 Each EOSTI shall meet the activation requirements of NIOSH certification as specified in 42 CFR 84.

6.2.4 Each EOSTI shall consist of at least the following:

(1) A sensing mechanism
(2) A signaling device

6.2.4.1 At least one of the two required EOSTI shall be independent of any other EOSTI.

6.2.4.2 The EOSTI sensing mechanism shall activate the signaling device(s).

6.2.4.3 The EOSTI signaling devices shall provide notification to the SCBA user of the activation of the EOSTI by stimulating one or more human senses.

6.2.4.4 Each EOSTI shall be permitted to have more than one signaling device, and each signaling device shall be permitted to stimulate more than one human sense.

6.2.4.5 Where one EOSTI signaling device stimulates only one human sense, the other EOSTI shall stimulate at least one different human sense.

6.2.5 The design of EOSTI shall be such that the failure of one EOSTI shall not affect the activation and operation of other EOSTI.

6.2.5.1 A failure mode and effects analysis shall be provided to the certification organization for each EOSTI.

6.2.5.2 The failure mode and effects analysis shall identify each potential failure mode for each component necessary for the EOSTI to function.

6.2.5.3 The failure mode and effects analysis shall demonstrate that the activation and operation of both EOSTI specified in 6.2.1 are not affected by any of the potential failure modes, as identified in accordance with 6.2.5.2, of all other EOSTI.

6.2.5.4 For purposes of the failure mode and effects analysis, power sources other than the air from the SCBA breathing air cylinder shall be considered as part of the EOSTI.

6.3 Heads-Up Display Design Requirements.

6.3.1 All SCBA shall be equipped with at least one heads-up display (HUD).

6.3.2 The HUD shall be activated with no additional procedures than those required to activate the SCBA breathing system.

6.3.3 Each time the SCBA breathing system is activated with the breathing air cylinder pressure of 17 bar (250 psi) or greater, the HUD shall provide a visual indication of activation for a minimum of 20 consecutive seconds.

6.3.4 Where HUD is provided with an external wiring disconnect, the wiring disconnect shall be designed to prevent accidental disconnection.

6.3.5 HUD shall provide at least visual displays of alert signals and information.

6.3.6 All HUD visual displays shall be visible to the SCBA wearer with the SCBA and facepiece properly donned and regardless of wearer's head movement.

6.3.7 HUD shall not use color as the only means of differentiating between alert signal displays and informational displays.

6.3.8 Visual Alert Signals.

6.3.8.1 HUD shall display visual alert signals for breathing air cylinder content specified in 6.3.8.5 and for battery condition specified in 6.3.8.6.

6.3.8.2 In addition to the mandatory visual alert signals specified in 6.3.8.5 and 6.3.8.6, additional visual alert signals to indicate when other status or conditions have occurred shall be permitted.

6.3.8.3 All visual alert signals shall be visible for a minimum of 20 consecutive seconds.

6.3.8.4 Each visual alert signal shall be identifiable, by the SCBA wearer, from any other visual alert signals or other informational displays provided on HUD or on the SCBA.

6.3.8.5 HUD shall display a visual alert signal for breathing air cylinder content when the breathing air in the SCBA cylinder has reduced to 50 percent of rated service content. This visual alert signal shall visibly flash at a frequency of not less than one per second.

6.3.8.6 Where batteries are used for HUD to comply with the requirements of this standard, HUD shall display a visual alert signal for low-battery capacity when the remaining battery life will provide a minimum of 2 hours of operation of the HUD at maximum electrical draw.

6.3.8.6.1 The low-battery visual alert signal shall be independent from, and physically distinguishable from, the breathing air cylinder content visual alert signal display.

6.3.8.6.2 The low-battery visual alert signal shall be displayed at all times when the battery condition is below the level specified in 6.3.8.6 while the HUD is activated.

6.3.9 Visual Informational Displays.

6.3.9.1 HUD shall display visual informational signals for at least breathing air cylinder content as specified in 6.3.9.5.

FAIR USE

6.3.9.2 In addition to the mandatory visual informational signal specified in 6.3.9.5, additional visual informational signals to indicate when other status or conditions have occurred shall be permitted.

6.3.9.3 All visual displays of information shall be permitted to flash at a frequency of not less than one per second for a minimum of 10 consecutive seconds every 60 seconds.

6.3.9.4 Where the visual display is not constantly visible, or is not visible for at least 10 consecutive seconds every 60 seconds, the HUD shall be provided with a manual activation of the display. The manual activation shall cause the display to be visible for at least 5 consecutive seconds for each activation.

6.3.9.5 HUD shall display a visual informational signal for breathing air cylinder content in at least four equal increments of the cylinder's total rated service content from full to one-quarter.

6.3.9.6 A display only in units of pressure shall not be permitted.

6.4 Rapid Intervention Crew/Company Universal Air Connection System.

6.4.1 Each SCBA shall be equipped with a rapid intervention crew/company (RIC) universal air connection (UAC) male fitting to allow replenishment of breathing air to the SCBA breathing air cylinder.

6.4.2 The RIC UAC male fitting shall meet the requirements specified in 6.4.5, and shall be located on each SCBA in a permanently fixed position.

6.4.3 The distance between the leading edge of the CGA fitting at the outlet of the SCBA cylinder valve and the leading edge of the RIC UAC male fitting shall be a maximum of 100 mm (4 in.).

6.4.4 A separate self-resetting relief valve shall be installed on the SCBA to protect the SCBA against overpressurization.

6.4.5 RIC UAC Male Fitting.

6.4.5.1 The RIC UAC male fitting shall be designed as specified in Figure 6.4.5.1.

6.4.5.2 The RIC UAC male fitting shall be capable of connecting to any RIC UAC female fitting.

6.4.5.3 The RIC UAC male fitting shall not interfere with any other operation of the SCBA.

6.4.5.4 RIC UAC male fittings shall be equipped with a dust cap or sealing plug to prevent dust, dirt, and debris from entering the fitting and to serve as a leakproof seal.

6.4.6 RIC UAC Female Fitting.

6.4.6.1 The RIC UAC female fitting shall be designed as specified in Figure 6.4.6.1.

6.4.6.2 The RIC UAC female fitting shall be capable of connecting to all RIC UAC male fittings.

6.4.6.3 RIC UAC female fittings shall be equipped with a dust cap or sealing plug to prevent dust, dirt, and debris from entering the fitting and to serve as a leakproof seal.

6.4.7 RIC UAC Filling Hose Assembly.

6.4.7.1 Each SCBA manufacturer shall make available an RIC UAC filling hose assembly that consists of a filling hose and a RIC UAC female fitting.

6.4.7.2 The RIC UAC filling hose assembly shall be a high-pressure, 310 bar (4500 psi) assembly designed to replenish breathing air to an SCBA breathing air cylinder.

6.4.7.3 The filling hose shall have an RIC UAC female fitting, that meets the requirements specified in 6.4.6, attached to the delivery end.

6.4.8 RIC UAC Coupling.

6.4.8.1 The complete RIC UAC male and female fittings shall constitute the RIC UAC coupling.

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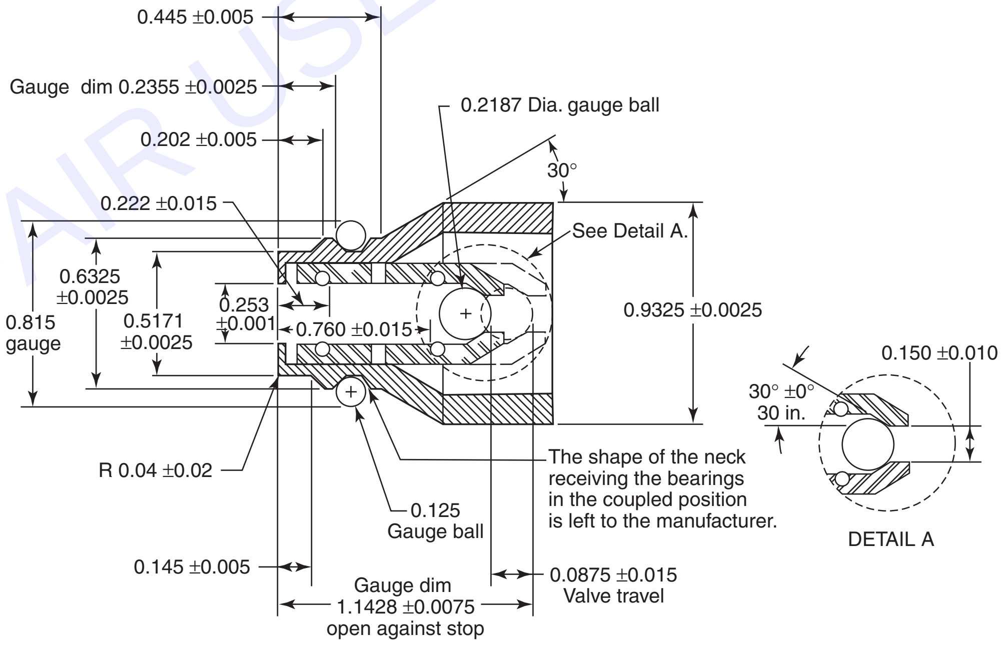

FIGURE 6.4.5.1 RIC UAC Male Fitting (all measurements in inches).

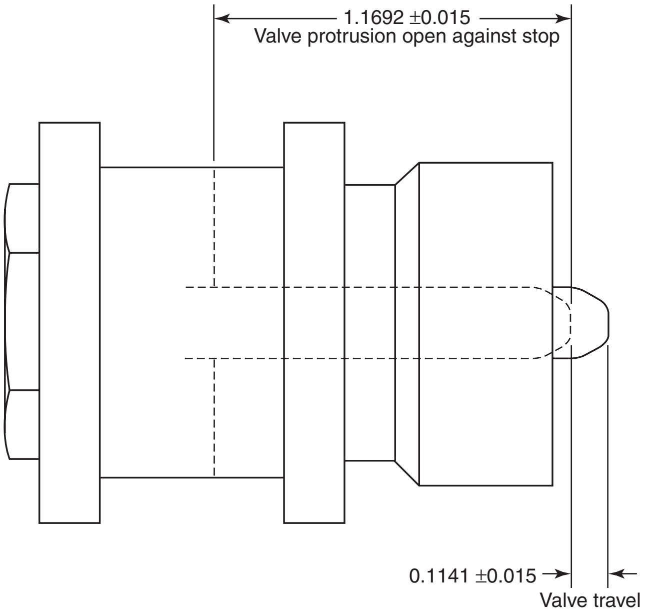

FIGURE 6.4.6.1 RIC UAC Female Fitting (all measurements in inches).

6.4.8.2 The RIC UAC coupling shall be capable of connection and disconnection with one hand while subjected to maximum operation pressure.

6.4.8.3 The RIC UAC coupling shall have an operating pressure of at least 310 bar (4500 psi).

6.5 Accessories.

6.5.1 Any accessories attached to SCBA shall not interfere with the function of the SCBA or with the function of any of the SCBA's component parts.

6.5.2 Where SCBA are provided with an accessory or accessories that are attached to or integrated with the SCBA, the SCBA, with accessories installed, shall meet all of the design and performance requirements of this standard. In all cases, such accessories shall not degrade the performance of the SCBA.

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Chapter 7 Performance Requirements

7.1* Air Flow Performance.

7.1.1 SCBA shall be tested for air flow performance as specified in Section 8.1, Air Flow Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.1.2 SCBA shall be tested for activation of EOSTI during the air flow performance testing specified in Section 8.1, Air Flow Performance Test, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.1.3 The SCBA shall be tested for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the air flow performance testing specified in Section 8.1, Air Flow Performance Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signal as specified in 6.3.8.5.

7.2 Environmental Temperature Performance.

7.2.1 SCBA shall be tested for environmental temperature performance as specified in Section 8.2, Environmental Temperature Tests.

7.2.1.1 SCBA shall be tested for cold environment as specified in 8.2.5.5, Test 1, and the SCBA facepiece pressure shall not be less than 0.00 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.2.1.2 SCBA shall be tested for hot environment as specified in 8.2.5.6, Test 2, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.2.1.3 SCBA shall be tested for hot-to-cold environment as specified in 8.2.5.7, Test 3, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.2.1.4 SCBA shall be tested for cold-to-hot environment as specified in 8.2.5.8, Test 4, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.2.2 SCBA shall be tested for activation of EOSTI during the environmental temperature performance as specified in Section 8.2, Environmental Temperature Tests.

7.2.2.1 SCBA shall be tested for cold environment as specified in 8.2.5.5, Test 1, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.2.2.2 SCBA shall be tested for hot environment as specified in 8.2.5.6, Test 2, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.2.2.3 SCBA shall be tested for hot-to-cold environment as specified in 8.2.5.7, Test 3, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.2.2.4 SCBA shall be tested for cold-to-hot environment as specified in 8.2.5.8, Test 4, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.2.3 SCBA shall be tested for the proper functioning of the HUD breathing air cylinder content informational display and the visual alert signal during the environmental temperature performance as specified in Section 8.2, Environmental Temperature Tests.

7.2.3.1 SCBA shall be tested for cold environment as specified in 8.2.5.5, Test 1, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signal as specified in 6.3.8.5.

7.2.3.2 SCBA shall be tested for hot environment as specified in 8.2.5.6, Test 2, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signal as specified in 6.3.8.5.

7.2.3.3 SCBA shall be tested for hot-to-cold environment as specified in 8.2.5.7, Test 3, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signal as specified in 6.3.8.5.

7.2.3.4 SCBA shall be tested for cold-to-hot environment as specified in 8.2.5.8, Test 4, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signals as specified in 6.3.8.5.

7.3 Vibration Resistance Performance.

7.3.1 SCBA shall be tested for vibration resistance as specified in Section 8.3, Vibration Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.3.2 SCBA shall be tested for activation of EOSTI during the vibration testing specified in Section 8.3, Vibration Test, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.3.3 The SCBA shall be tested for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the vibration testing specified in Section 8.3, Vibration Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signal as specified in 6.3.8.5.

7.4 Fabric Flame Resistance Performance. All fabric components of SCBA that are used to secure the SCBA to the wearer shall be tested for flame resistance as specified in Section 8.4, Fabric Flame Tests, and shall have an average char length of not more than 100 mm (4 in.), shall have an average afterflame of not more than 2.0 seconds, and shall not melt or drip.

7.5 Fabric Heat Resistance Performance. All fabric components of SCBA that are used to secure the SCBA to the wearer shall be tested for heat resistance as specified in Section 8.5, Fabric Heat Tests, and shall not melt or ignite.

7.6 Thread Heat Resistance Performance. All thread used in SCBA components shall be tested for heat resistance as specified in Section 8.6, Thread Heat Test, and shall not melt or ignite.

7.7 Corrosion Resistance Performance.

7.7.1 SCBA shall be tested for corrosion resistance as specified in Section 8.7, Accelerated Corrosion Test, and any corrosion shall not prohibit the proper use and function, as specified in the manufacturer's instructions, of any control or operating feature of the SCBA.

7.7.2 SCBA shall be tested for corrosion resistance as specified in Section 8.7, Accelerated Corrosion Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.7.3 SCBA shall be tested for activation of EOSTI during the corrosion resistance testing specified in Section 8.7, Accelerated Corrosion Test, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.7.4 The SCBA shall be tested for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the corrosion resistance testing specified in Section 8.7, Accelerated Corrosion Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signal as specified in 6.3.8.5.

7.8 Particulate Resistance Performance.

7.8.1 SCBA shall be tested for particulate resistance as specified in Section 8.8, Particulate Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.8.2 SCBA shall be tested for activation of EOSTI during the particulate resistance testing specified in Section 8.8, Particulate Test, and the EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.8.3 SCBA shall be tested for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the particulate resistance testing specified in Section 8.8, Particulate Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signal as specified in 6.3.8.5.

7.9* Facepiece Lens Abrasion Resistance Performance. SCBA facepiece lenses shall be tested for abrasion resistance as specified in Section 8.9, Facepiece Lens Abrasion Test, and the average value of the tested specimens shall not exhibit a delta haze greater than 14 percent.

7.10* Communications Performance. SCBA incorporating specimens of the SCBA's primary communication means, as identified by the SCBA manufacturer, shall be tested for communications performance as specified in Section 8.10, Communication Test, and shall have an average calculated value of not less than 72 percent.

7.11 Heat and Flame Resistance Performance.

7.11.1 SCBA shall be tested for heat and flame resistance as specified in Section 8.11, Heat and Flame Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.11.2 SCBA and SCBA accessories shall be tested for heat and flame resistance as specified in Section 8.11, Heat and Flame Test, and no components of the SCBA and no accessories shall have an afterflame of more than 2.2 seconds.

FAIR USE

7.11.3 SCBA shall be tested for heat and flame resistance as specified in Section 8.11, Heat and Flame Test, and no component of the SCBA shall separate or fail in such a manner that would cause the SCBA to be worn and used in a position not specified by the manufacturer's instructions.

7.11.4 The SCBA facepiece shall be tested for heat and flame resistance as specified in Section 8.11, Heat and Flame Test, and the facepiece lens shall not obscure vision below the 20/100 vision criterion.

7.11.5 SCBA shall be tested for activation of EOSTI during the heat and flame resistance testing specified in Section 8.11, Heat and Flame Test, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the air flow performance test.

7.11.6 SCBA shall be tested for functioning of the HUD breathing air cylinder content informational display and visual alert signals during the heat and flame resistance testing specified in Section 8.11, Heat and Flame Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9 and shall display the visual alert signal as specified in 6.3.8.5.

7.12 Carbon Dioxide (CO_2) Content Performance. SCBA facepieces shall be tested for CO_2 content as specified in Section 8.12, Facepiece Carbon Dioxide Content Test, and the CO_2 content in the inhalation air shall not be greater than 1.5 percent by volume.

7.13 Additional SCBA EOSTI Performance.

7.13.1 EOSTI Independent Activation.

7.13.1.1 Each EOSTI shall be tested for independent activation as specified in Section 8.13, EOSTI Independent Activation Test, and the activation of the alarm of each EOSTI shall be independent of any other EOSTI.

7.13.1.2 After activation of the unblocked EOSTI, the alarm signal shall remain active at least until the cylinder pressure drops below 17.0 bar (250 psi).

7.13.2 EOSTI Alarm Recognition. Each EOSTI shall be tested for alarm recognition as specified in Section 8.14, EOSTI Recognition Test, and the EOSTI alarm signal shall be recognized in 10 seconds or less.

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7.14 Additional SCBA HUD Performance.

7.14.1 Where HUD incorporates exposed wiring, the wire's entry into any associated components shall be tested for connection strength as specified in Section 8.15, HUD Wiring Connection Strength Test, and the HUD shall remain functional.

7.14.2 Where batteries are used for HUD to comply with the requirements of this standard, HUD shall be tested for proper functioning of visual alert signals and visual information displays as specified in Section 8.16, HUD Low-Battery Visual Alert Signal Test, and HUD shall continue to function at maximum current draw for a minimum of 2 hours following the activation of the low-battery visual alert signal and shall display the visual alert signals specified in 6.3.8.5 and 6.3.8.6 and shall display the visual information for the breathing air cylinder content as specified in 6.3.9.

7.14.3 HUD shall be tested for splash resistance as specified in Section 8.17, HUD Liquid Splash Resistance Test, and shall display the visual information for the breathing air cylinder content as specified in 6.3.9, and shall display the visual alert signal as specified in 6.3.8.5.

7.14.4 Where batteries are used for HUD to comply with the requirements of this standard, HUD shall be tested for splash resistance as specified in Section 8.17, HUD Liquid Splash Resistance Test, and shall have no water in the battery compartment at the completion of the test.

7.14.5 HUD shall be tested for wearer visibility as specified in Section 8.18, HUD Visibility Test, and each informational display and visual alert signal shall be observable, distinct, and identifiable in both darkness and bright light.

7.14.6 Where the HUD displays are external to the facepiece and the gap between the HUD display and the facepiece lens is greater than 1 mm (1⁄32 in.), HUD displays shall be tested for wearer visibility while obscured as specified in Section 8.19, HUD Obscuration Test, and each informational display and visual alert signal shall be observable, distinct, and identifiable.

7.14.7 HUD shall be tested for disabling glare as specified in Section 8.20, HUD Disabling Glare Test, and the test subject shall be able to read at least 9 out of 10 selected letters when each visual alert signal is activated.

7.15 Rapid Intervention Crew/Company Universal Air Connection Performance Requirements.

7.15.1 SCBA shall be tested for cylinder refill breathing performance as specified in Section 8.21, Cylinder Refill Breathing Performance Test, and the SCBA facepiece pressure shall not be less than 0.00 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

7.15.2 SCBA shall be tested for RIC UAC system fill rate performance as specified in Section 8.22, RIC UAC System Fill Rate Test, and the maximum allowable fill time shall be 3.0 minutes.

Chapter 8 Test Methods

8.1 Air Flow Performance Test.

8.1.1 Application. This test method shall apply to complete SCBA.

8.1.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.1.3 Specimen Preparation.

8.1.3.1 Specimens for conditioning shall be complete SCBA.

8.1.3.2 Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), with a relative humidity (RH) of 50 percent, ±25 percent.

8.1.3.3* The air used in the SCBA breathing air cylinders shall have a minimum air quality of Grade D as specified in ANSI/CGA G-7.1, *Commodity Specifications for Air,* and shall have a water content not exceeding 24 ppm by volume and shall have a particulate level of 5 mg/m^3 air.

8.1.4 Apparatus.

8.1.4.1 A test headform as specified in Figure 8.1.4.1, or equivalent, shall be used.

8.1.4.2 A pressure probe shall be attached to the test headform to monitor facepiece pressure.

8.1.4.2.1 The pressure probe shall be a 6.5 mm (¼ in.) O.D. with a 1.6 mm (1⁄16 in.) wall thickness metal tube having one open end and one closed end.

8.1.4.2.2 The closed end of the pressure probe shall have four equally spaced holes, each 1.5 mm, ±0.1 mm (1⁄16 in.), and each shall be positioned 6.5 mm, ±0.4 mm (¼ in.) from the end of the pressure probe.

8.1.4.2.3 The closed end of the pressure probe shall extend through the test headform, exiting out the center of the left eye.

8.1.4.2.4 The pressure probe shall extend 13 mm, +1.5 mm/−0 mm (½ in., +1⁄16 in./−0 in.) outward from the surface of the center of the left eye.

8.1.4.3 A length of tubing, including connections, of a 1.5 m (5 ft) length with a nominal 5 mm (3⁄16 in.) I.D. flexible smoothbore tubing with a nominal 1.5 mm (1⁄16 in.) wall thickness shall be permitted to be connected to the open end of the pressure probe and to the inlet of the pressure transducer.

8.1.4.4 A differential pressure transducer having the following characteristics shall be used:

(1) Range: 225 mm (8.9 in.) of water differential
(2) Linearity: ±0.5 percent Full Scale (FS) best straight line
(3) Line pressure effect: less than 1 percent FS zero shift/1000 psig
(4) Output: ±2.5 Vdc for +FS
(5) Output ripple: 10 mV peak to peak
(6) Regulation: FS output shall not change more than ±0.1 percent for input voltage change from 22 to 35 Vdc
(7) Temperature, operating: −54°C to 121°C (−65°F to 250°F)
(8) Temperature, compensated: −18°C to 71°C (0°F to 160°F)
(9) Temperature effects: within 2 percent FS/55.6°C (100°F) error band

8.1.4.5 The differential pressure transducer shall be connected to a strip chart recorder having the following characteristics:

(1) Chart width of 250 mm
(2) Pen speed of at least 750 mm/sec
(3) Accuracy of ±0.25 percent FS
(4) Input voltage range of 1 V FS
(5) Span set at 25 mm (1 in.) of chart per 25.4 mm (1 in.) water column

8.1.4.6 The test headform shall be equipped with a breathing passage.

8.1.4.6.1 The breathing passage shall lead from the mouth of the test head to the lung.

8.1.4.6.2 The sum of the volumes of the lung, when fully extended to a 3.4 L tidal volume position, and the breathing passage shall not exceed 4.0 L.

8.1.4.6.3 The breathing passage shall be located on the centerline of the mouth and shall be flush with the test headform.

8.1.4.7 The breathing passage shall extend a minimum of 200 mm (8 in.) and a maximum of 450 mm (18 in.).

8.1.4.8 Where flexible smoothbore tubing is used from the metal breathing tube to the inlet connection of the breathing machine, it shall have a maximum length of 1.2 m (4 ft) and a 19 mm (¾ in.) I.D. with a nominal 3 mm (⅛ in.) wall thickness.

8.1.4.9 The breathing machine shown in Figure 8.1.4.9 shall be used.

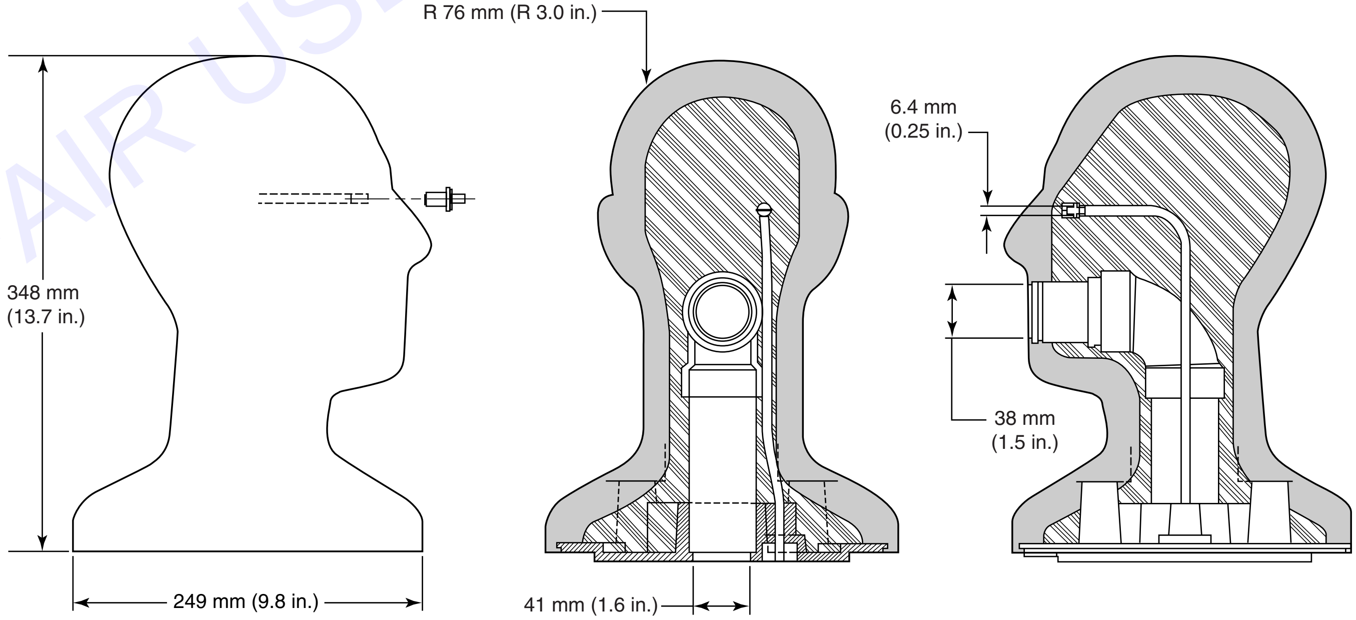

FIGURE 8.1.4.1 Test Headform.

FAIR USE

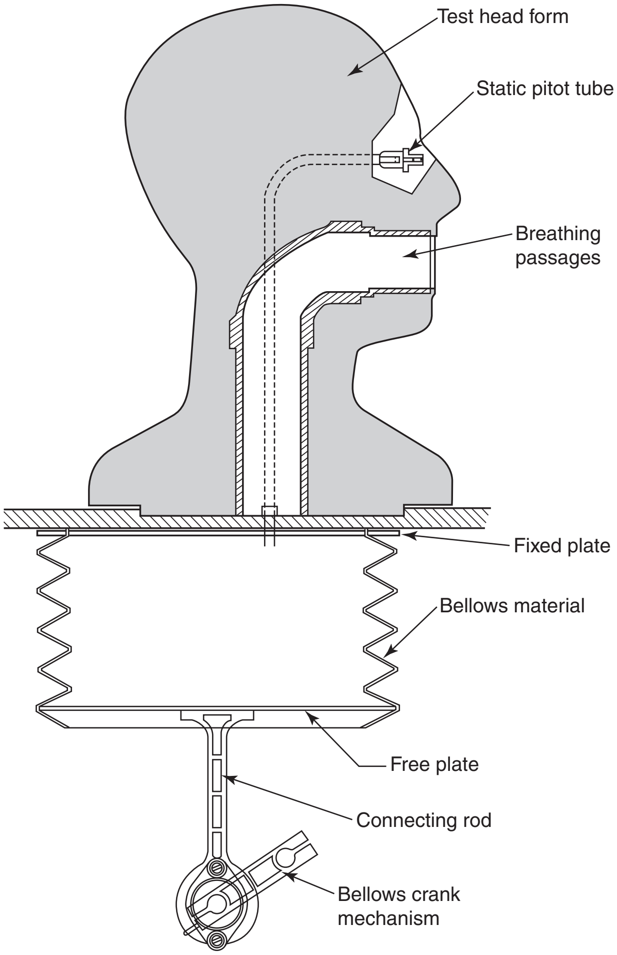

FIGURE 8.1.4.9 Breathing Machine.

FAIR USE

8.1.4.9.1 The breathing machine shall consist of a flexible bellows material attached at one end to a fixed plate and at the other end by a free plate constrained to two degrees of freedom.

8.1.4.9.2 The free plate shall be connected to a rotating shaft by means of a connecting rod, vibration damper, and bell crank mechanism.

8.1.4.9.3 The bell crank mechanism shall have a center-to-center distance of 57 mm, ±0.005 mm (2¼ in., ±0.01 in.).

8.1.4.9.4 The connecting rod shall have a center-to-center free plate distance of 133 mm, ±0.005 mm (5¼ in., ±0.01 in.).

8.1.4.9.5 The vibration damper shall be a rubber-to-metal bonded anti-vibration mounting with a mounting flange hole spacing of 50 mm, ±5 mm (2 in., ±3⁄16 in.), an overall height of 20 mm, ±2 mm (3⁄16 in., ±5⁄64 in.), and have a static force/displacement curve with a slope of 11.5 N/mm, ±0.5 N/mm.

8.1.4.10 The bellows material shall consist of neoprene impregnated nylon fabric convoluted tubing.

8.1.4.10.1 The tubing shall have an I.D. of 200 mm, ±5 mm (8 in., ±3⁄16 in.) and an O.D. of 250 mm, ±5 mm (10 in., ±3⁄16 in.).

8.1.4.10.2 The nominal wall thickness of the tubing shall be 1.4 mm (1⁄32 in.).

8.1.4.10.3 The breathing machine shall have the capability to conduct breathing resistance testing at 40 L/min, ±1.0 L/min and 103 L/min, ±3.0 L/min.

8.1.4.10.4 The tidal volume of the lung shall determine the volume of air moved during each inhalation/exhalation cycle.

8.1.4.10.5 The air flow shall be determined by three factors: the number of inhalation/exhalation cycles per minute, the tidal volume of the lung, and the breathing waveform.

8.1.4.10.6 The breathing waveform shall be produced by reciprocal action of the shaft.

8.1.4.10.7 Inspired and expired volumes as a function of time shall be incorporated in accordance with the values given in Table 8.1.4.10.7(a) and Table 8.1.4.10.7(b), which list the linear displacement of the bellows free plate as a function of time for 103 L/min volume and 40 L/min volume work rates.

Table 8.1.4.10.7(a) Lung Breathing Waveforms for 103 L/min Volume Work Rate

Step No.	Time (sec)	Inspire/Expire	Volume (L, ±0.1)	Volume Change (L, ±5%)
0	0.00	—	–1.7	–0.012
1	0.02	Inspire	–1.688	0.012
2	0.04	Inspire	–1.662	0.025
3	0.06	Inspire	–1.626	0.036
4	0.08	Inspire	–1.581	0.045
5	0.10	Inspire	–1.529	0.052
6	0.12	Inspire	–1.471	0.058
7	0.14	Inspire	–1.409	0.062
8	0.16	Inspire	–1.345	0.064
9	0.18	Inspire	–1.277	0.068
10	0.20	Inspire	–1.207	0.07
11	0.22	Inspire	–1.134	0.073
12	0.24	Inspire	–1.059	0.075
13	0.26	Inspire	–0.984	0.076
14	0.28	Inspire	–0.906	0.077
15	0.30	Inspire	–0.828	0.079
16	0.32	Inspire	–0.748	0.08
17	0.34	Inspire	–0.667	0.081
18	0.36	Inspire	–0.586	0.081
19	0.38	Inspire	–0.504	0.082
20	0.40	Inspire	–0.421	0.083
21	0.42	Inspire	–0.337	0.084
22	0.44	Inspire	–0.254	0.084
23	0.46	Inspire	–0.169	0.085
24	0.48	Inspire	–0.085	0.085
25	0.50	Inspire	0	0.085
26	0.52	Inspire	0.085	0.085
27	0.54	Inspire	0.169	0.085
28	0.56	Inspire	0.254	0.085
29	0.58	Inspire	0.337	0.084
30	0.60	Inspire	0.421	0.084

Table 8.1.4.10.7(a) *Continued*

Step No.	Time (sec)	Inspire/Expire	Volume (L, ±0.1)	Volume Change (L, ±5%)
31	0.62	Inspire	0.504	0.083
32	0.64	Inspire	0.586	0.082
33	0.66	Inspire	0.667	0.081
34	0.68	Inspire	0.748	0.081
35	0.70	Inspire	0.828	0.08
36	0.72	Inspire	0.906	0.079
37	0.74	Inspire	0.984	0.077
38	0.76	Inspire	1.059	0.076
39	0.78	Inspire	1.134	0.075
40	0.80	Inspire	1.207	0.073
41	0.82	Inspire	1.277	0.07
42	0.84	Inspire	1.345	0.068
43	0.86	Inspire	1.409	0.064
44	0.88	Inspire	1.471	0.062
45	0.90	Inspire	1.529	0.058
46	0.92	Inspire	1.581	0.052
47	0.94	Inspire	1.626	0.045
48	0.96	Inspire	1.662	0.036
49	0.98	Inspire	1.688	0.025
50	1.00	—	1.7	0.012
51	1.02	Expire	1.688	–0.012
52	1.04	Expire	1.662	–0.025
53	1.06	Expire	1.626	–0.036
54	1.08	Expire	1.581	–0.045
55	1.10	Expire	1.529	–0.052
56	1.12	Expire	1.471	–0.058
57	1.14	Expire	1.409	–0.062
58	1.16	Expire	1.345	–0.064
59	1.18	Expire	1.277	–0.068
60	1.20	Expire	1.207	–0.07
61	1.22	Expire	1.134	–0.073
62	1.24	Expire	1.059	–0.075
63	1.26	Expire	0.984	–0.076
64	1.28	Expire	0.906	–0.077
65	1.30	Expire	0.828	–0.079
66	1.32	Expire	0.748	–0.08
67	1.34	Expire	0.667	–0.081
68	1.36	Expire	0.586	–0.081
69	1.38	Expire	0.504	–0.082
70	1.40	Expire	0.421	–0.083
71	1.42	Expire	0.337	–0.084
72	1.44	Expire	0.254	–0.084
73	1.46	Expire	0.169	–0.085
74	1.48	Expire	0.085	–0.085
75	1.50	Expire	0	–0.085
76	1.52	Expire	–0.085	–0.085
77	1.54	Expire	–0.169	–0.085
78	1.56	Expire	–0.254	–0.085
79	1.58	Expire	–0.337	–0.084
80	1.60	Expire	–0.421	–0.084
81	1.62	Expire	–0.504	–0.083
82	1.64	Expire	–0.586	–0.082
83	1.66	Expire	–0.667	–0.081
84	1.68	Expire	–0.748	–0.081
85	1.70	Expire	–0.828	–0.08
86	1.72	Expire	–0.906	–0.079
87	1.74	Expire	–0.984	–0.077
88	1.76	Expire	–1.059	–0.076
89	1.78	Expire	–1.134	–0.075
90	1.80	Expire	–1.207	–0.073
91	1.82	Expire	–1.277	–0.07
92	1.84	Expire	–1.345	–0.068
93	1.86	Expire	–1.409	–0.064
94	1.88	Expire	–1.471	–0.062
95	1.90	Expire	–1.529	–0.058
96	1.92	Expire	–1.581	–0.052
97	1.94	Expire	–1.626	–0.045
98	1.96	Expire	–1.662	–0.036
99	1.98	Expire	–1.688	–0.025

Table 8.1.4.10.7(b) Lung Breathing Waveforms for 40 L/min Volume Work Rate

Step No.	Time (sec)	Inspire/Expire	Volume (L, ±0.1)	Volume Change (L, ±5%)
0	0	—	–0.833	0.001
1	0.025	Inspire	–0.831	0.002
2	0.050	Inspire	–0.825	0.005
3	0.075	Inspire	–0.816	0.009
4	0.100	Inspire	–0.803	0.013
5	0.125	Inspire	–0.787	0.016
6	0.150	Inspire	–0.768	0.019
7	0.175	Inspire	–0.745	0.022
8	0.200	Inspire	–0.720	0.025
9	0.225	Inspire	–0.692	0.028
10	0.250	Inspire	–0.661	0.031
11	0.275	Inspire	–0.628	0.033
12	0.300	Inspire	–0.592	0.035
13	0.325	Inspire	–0.555	0.038
14	0.350	Inspire	–0.515	0.039
15	0.375	Inspire	–0.474	0.041
16	0.400	Inspire	–0.431	0.043
17	0.425	Inspire	–0.387	0.044
18	0.450	Inspire	–0.341	0.046
19	0.475	Inspire	–0.295	0.047
20	0.500	Inspire	–0.247	0.048
21	0.525	Inspire	–0.198	0.049
22	0.550	Inspire	–0.149	0.049
23	0.575	Inspire	–0.100	0.050
24	0.600	Inspire	–0.050	0.050

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Table 8.1.4.10.7(b) *Continued*

Step No.	Time (sec)	Inspire/Expire	Volume (L, ±0.1)	Volume Change (L, ±5%)
25	0.625	Inspire	0.000	0.050
26	0.650	Inspire	0.051	0.050
27	0.675	Inspire	0.100	0.050
28	0.700	Inspire	0.150	0.050
29	0.725	Inspire	0.199	0.049
30	0.750	Inspire	0.248	0.048
31	0.775	Inspire	0.295	0.048
32	0.800	Inspire	0.342	0.047
33	0.825	Inspire	0.388	0.046
34	0.850	Inspire	0.432	0.044
35	0.875	Inspire	0.475	0.043
36	0.900	Inspire	0.516	0.041
37	0.925	Inspire	0.555	0.039
38	0.950	Inspire	0.592	0.037
39	0.975	Inspire	0.628	0.035
40	1.000	Inspire	0.661	0.033
41	1.025	Inspire	0.691	0.031
42	1.050	Inspire	0.719	0.028
43	1.075	Inspire	0.744	0.025
44	1.100	Inspire	0.767	0.022
45	1.125	Inspire	0.786	0.019
46	1.150	Inspire	0.802	0.016
47	1.175	Inspire	0.814	0.013
48	1.200	Inspire	0.823	0.009
49	1.225	Inspire	0.829	0.005
50	1.250	—	0.833	0.004
51	1.275	Expire	0.831	−0.002
52	1.300	Expire	0.825	−0.005
53	1.325	Expire	0.816	−0.009
54	1.350	Expire	0.803	−0.013
55	1.375	Expire	0.787	−0.016
56	1.400	Expire	0.768	−0.019
57	1.425	Expire	0.745	−0.022
58	1.450	Expire	0.720	−0.025
59	1.475	Expire	0.692	−0.028
60	1.500	Expire	0.661	−0.031
61	1.525	Expire	0.628	−0.033
62	1.550	Expire	0.592	−0.035
63	1.575	Expire	0.555	−0.038
64	1.600	Expire	0.515	−0.039
65	1.625	Expire	0.474	−0.041
66	1.650	Expire	0.431	−0.043
67	1.675	Expire	0.387	−0.044
68	1.700	Expire	0.341	−0.046
69	1.725	Expire	0.295	−0.047
70	1.750	Expire	0.247	−0.048
71	1.775	Expire	0.198	−0.049
72	1.800	Expire	0.149	−0.049
73	1.825	Expire	0.100	−0.050
74	1.850	Expire	0.050	−0.050
75	1.875	Expire	0.000	−0.050
76	1.900	Expire	−0.051	−0.050
77	1.925	Expire	−0.100	−0.050
78	1.950	Expire	−0.150	−0.050
79	1.975	Expire	−0.199	−0.049
80	2.000	Expire	−0.248	−0.048
81	2.025	Expire	−0.295	−0.048
82	2.050	Expire	−0.342	−0.047
83	2.075	Expire	−0.388	−0.046
84	2.100	Expire	−0.432	−0.044
85	2.125	Expire	−0.475	−0.043
86	2.150	Expire	−0.516	−0.041
87	2.175	Expire	−0.555	−0.039
88	2.200	Expire	−0.592	−0.037
89	2.225	Expire	−0.628	−0.035
90	2.250	Expire	−0.661	−0.033
91	2.275	Expire	−0.691	−0.031
92	2.300	Expire	−0.719	−0.028
93	2.325	Expire	−0.744	−0.025
94	2.350	Expire	−0.767	−0.022
95	2.375	Expire	−0.786	−0.019
96	2.400	Expire	−0.802	−0.016
97	2.425	Expire	−0.814	−0.013
98	2.450	Expire	−0.823	−0.009
99	2.475	Expire	−0.829	−0.005

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8.1.4.10.8 Switching between the two work rates shall be performed within 10 seconds.

8.1.4.10.9 The construction of the breathing machine shall be such that the respiration rate, tidal volume, peak flow, and facepiece pressure measurement system accuracy are unaffected by temperature changes caused by the environmental air flow performance tests as specified in Section 8.2, End-of-Service-Time Indicator (EOSTI).

8.1.5 Procedure.

8.1.5.1* The test setup for conducting the air flow performance test shall be calibrated at least once each day before conducting tests and shall be verified at least once each day after testing.

8.1.5.1.1 The calibration procedure utilized for the differential pressure transducer shall consist of confirming at least three different pressures between 0 mm and 125 mm (0 in. and 5 in.) water column.

8.1.5.1.2 The pressure shall be measured using an incline manometer or equivalent with a scale measuring in increments of ±0.5 mm (±0.02 in.) water column or less.

8.1.5.2 The SCBA being tested shall utilize a fully charged breathing air cylinder.

8.1.5.3 The facepiece of the SCBA being tested shall be secured to the test headform. The facepiece seal to the headform shall assure that an initial pressure of 25 mm, ±2.5 mm (1 in., ±0.1 in.) water column below ambient shall not decay by more than 5 mm (0.2 in.) water column in 5 seconds.

8.1.5.4 The remaining components of the SCBA shall be mounted to simulate the proper wearing position as specified by the manufacturer's instructions.

8.1.5.5 SCBA shall be tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), RH of 50 percent, ±25 percent.

8.1.5.6 The air flow performance test shall begin after 5 cycles of the breathing machine and continue to operate through at least 30 cycles of the breathing machine after actuation of each EOSTI specified in Section 6.2, End-of-Service-Time Indicator.

8.1.5.7 The breathing machine shall be set at a rate of 103 L/min, ±3 L/min with a respiratory frequency of 30 breaths/min, ±1 breaths/min.

8.1.6 Report.

8.1.6.1 The facepiece peak inhalation pressure and peak exhalation pressure shall be recorded and reported for each test.

8.1.6.2 The activation and operation, or failure to activate and operate, of the EOSTI shall be recorded and reported.

8.1.6.3 The activation and identification of HUD visual alert signals shall be recorded and reported.

8.1.7 Interpretation.

8.1.7.1 The peak inhalation pressure and peak exhalation pressure shall be used to determine pass/fail performance.

8.1.7.2 One or more specimens failing this test shall constitute failing performance.

8.1.7.3 Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

8.1.7.4 Failure of the HUD to display the breathing air cylinder content or display the visual alert signal during the test shall constitute failing performance.

8.2 Environmental Temperature Tests.

8.2.1 Application. This test method shall apply to complete SCBA.

8.2.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.2.3 Specimen Preparation.

8.2.3.1 Specimens for conditioning shall be complete SCBA.

8.2.3.2 Prior to testing, the SCBA shall be placed in an ambient environment of 22°C, ±3°C (72°F, ±5°F) with a relative humidity of 50 percent, ±25 percent, for a minimum 12-hour dwell period.

8.2.4 Apparatus.

8.2.4.1 The SCBA shall be placed in an environmental chamber and positioned to simulate the normal wearing position of the SCBA on a fire fighter as specified by the manufacturer.

8.2.4.2 A test headform as specified in 8.1.4 shall be equipped with a thermocouple or other temperature-sensing element to monitor SCBA test chamber temperature.

8.2.4.3 The thermocouple or other temperature-sensing element used shall be attached to the test headform in a manner in which it will be directly exposed to the chamber atmosphere.

8.2.4.4 The test headform shall be connected to the breathing machine specified in Section 8.1, Air Flow Performance Test.

8.2.4.5 The breathing machine shall be permitted to be located either inside or outside the environmental chamber.

8.2.5 Procedure.

8.2.5.1 The variation in pressure extremes caused by the environmental test configuration shall be determined in the following manner. The air flow performance test as specified in Section 8.1, Air Flow Performance Test, shall be carried out using the configuration specified in 8.2.4 at the 103 L/min, ±3 L/min ventilation rate. The difference in pressure between the two tests shall be calculated by subtracting the values obtained using the configuration defined in 8.2.4 from the values obtained using the configuration specified in Section 8.1, Air Performance Test.

8.2.5.2 The facepiece pressure during each entire test shall be read from the strip chart recorder and corrected by adding the value of the difference in pressure calculated in 8.2.5.1 to determine pass/fail as specified in 7.2.1.1 through 7.2.1.4.

8.2.5.3 These environmental temperature tests shall be permitted to be conducted in any sequence.

8.2.5.4 The dwell period between environmental temperature tests shall be used for refilling the breathing air cylinder and visually inspecting the SCBA for any gross damage that could cause unsafe test conditions.

8.2.5.5 Test 1.

8.2.5.5.1 The SCBA shall be cold soaked at −32°C, ±1°C (−25°F, ±2°F) for a minimum of 12 hours.

8.2.5.5.2 The SCBA shall then be tested for air flow performance as specified in Section 8.1, Air Flow Performance Test, at a chamber air temperature of −32°C, ±5°C (−25°F, ±10°F).

8.2.5.6 Test 2.

8.2.5.6.1 The SCBA shall be hot soaked at 71°C, ±1°C (160°F, ±2°F) for a minimum of 12 hours.

8.2.5.6.2 The SCBA shall then be tested for air flow performance as specified in Section 8.1, Air Flow Performance Test, at a chamber air temperature of 71°C, ±5°C (160°F, ±10°F).

8.2.5.7 Test 3.

8.2.5.7.1 The SCBA shall be hot soaked at 71°C, ±1°C (160°F, ±2°F) for a minimum of 12 hours.

8.2.5.7.2 Immediately following the 12-hour hot soak, the SCBA shall be transferred to a chamber with an air temperature of −32°C, ±1°C (−25°F, ±2°F).

8.2.5.7.3 The SCBA shall then be tested for air flow performance as specified in Section 8.1, Air Performance Test, at a chamber air temperature of −32°C, ±5°C (−25°F, ±10°F).

8.2.5.7.4 The air flow performance test shall commence within 3 minutes after removal of the SCBA from hot soak.

8.2.5.8 Test 4.

8.2.5.8.1 The SCBA shall be cold soaked at −32°C, ±1°C (−25°F, ±2°F) for a minimum of 12 hours.

8.2.5.8.2 Immediately following the 12-hour cold soak, the SCBA shall be transferred to a chamber with an air temperature of 71°C, ±1°C (160°F, ±2°F).

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8.2.5.8.3 The SCBA shall then be tested for air flow performance as specified in Section 8.1, Air Flow Performance Test, at a chamber air temperature of 71°C, ±5°C (160°F, ±10°F).

8.2.5.8.4 The air flow performance test shall commence within 3 minutes after removal of the SCBA from cold soak.

8.2.6 Report.

8.2.6.1 The facepiece peak inhalation pressure and peak exhalation pressure shall be recorded and reported for each test condition.

8.2.6.2 The activation and operation, or failure to activate and operate, of the EOSTI shall be recorded and reported.

8.2.6.3 The activation and identification of HUD visual alert signals shall be recorded and reported.

8.2.7 Interpretation.

8.2.7.1 The peak inhalation and peak exhalation shall be used to determine pass/fail performance for each test procedure.

8.2.7.2 One or more specimens failing any test procedure shall constitute failing performance.

8.2.7.3 Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

8.2.7.4 Failure of the HUD to display the breathing air cylinder content or display the visual alert signal during the test shall constitute failing performance.

8.3 Vibration Test.

8.3.1 Application. This test method shall apply to complete SCBA.

8.3.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.3.3 Specimen Preparation.

8.3.3.1 Specimens for conditioning shall be complete SCBA.

8.3.3.2 Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), with a RH of 50 percent, ±25 percent.

8.3.4 Apparatus.

8.3.4.1 SCBA shall be tested on a typical package tester within the compartments specified in 8.3.4.2 through 8.3.4.4.

8.3.4.2 Compartments shall be set up as specified in Figure 8.3.4.2(a) and Figure 8.3.4.2(b).

8.3.4.2.1 The sides and base of the compartments shall be constructed of nominal 6 mm (¼ in.) stainless steel, and the top of the compartments shall remain open.

8.3.4.2.2 There shall be no burrs, sharp edges, surface discontinuities, or fasteners on the internal surfaces of the holding boxes.

8.3.4.3 The large compartments shall encase the complete SCBA.

8.3.4.3.1 SCBA regulators and hose shall remain attached to the complete SCBA.

8.3.4.3.2 Regulators shall be allowed to be placed in the regulator holder of the SCBA.

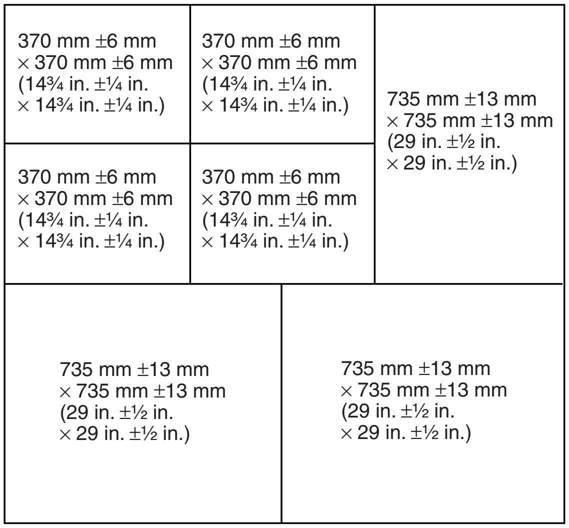

370 mm ±6 mm × 370 mm ±6 mm (14¾ in. ±¼ in. × 14¾ in. ±¼ in.)
370 mm ±6 mm × 370 mm ±6 mm (14¾ in. ±¼ in. × 14¾ in. ±¼ in.)
735 mm ±13 mm × 735 mm ±13 mm (29 in. ±½ in. × 29 in. ±½ in.)
370 mm ±6 mm × 370 mm ±6 mm (14¾ in. ±¼ in. × 14¾ in. ±¼ in.)
370 mm ±6 mm × 370 mm ±6 mm (14¾ in. ±¼ in. × 14¾ in. ±¼ in.)
735 mm ±13 mm × 735 mm ±13 mm (29 in. ±½ in. × 29 in. ±½ in.)
735 mm ±13 mm × 735 mm ±13 mm (29 in. ±½ in. × 29 in. ±½ in.)

FIGURE 8.3.4.2(a) Vibration Table Compartments — Top View (Not to Scale).

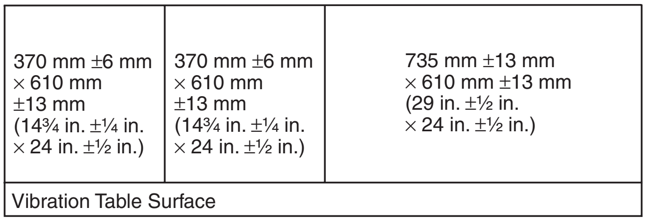

370 mm ±6 mm × 610 mm ±13 mm (14¾ in. ±¼ in. × 24 in. ±½ in.)
370 mm ±6 mm × 610 mm ±13 mm (14¾ in. ±¼ in. × 24 in. ±½ in.)
735 mm ±13 mm × 610 mm ±13 mm (29 in. ±½ in. × 24 in. ±½ in.)
Vibration Table Surface

FIGURE 8.3.4.2(b) Vibration Table Compartments — Side View (Not to Scale).

8.3.4.3.3 The SCBA facepiece and those components that attach directly to the facepiece, excluding regulators, shall not be included in the SCBA compartment.

8.3.4.4 The small compartments shall encase the facepiece and those components that attach directly to the facepiece, excluding the regulator and associated hose.

8.3.4.5* The breathing air cylinder of the SCBA shall be replaced by a surrogate cylinder.

8.3.4.6 The surrogate cylinder and cylinder valve shall be of identical design and construction as the breathing gas cylinder and cylinder valve of the SCBA to be tested.

8.3.4.7 The mass of the breathing air of a fully pressurized breathing air cylinder shall be replaced in the surrogate cylinder with a substitute mass. The substitute mass shall consist of a brass rod and surrounding foam constructed as shown in Figure 8.3.4.7.

8.3.4.8 The surrogate cylinder and cylinder valve with the substitute mass shall have the same total mass, ±5 percent, as the fully pressurized breathing air cylinder and cylinder valve.

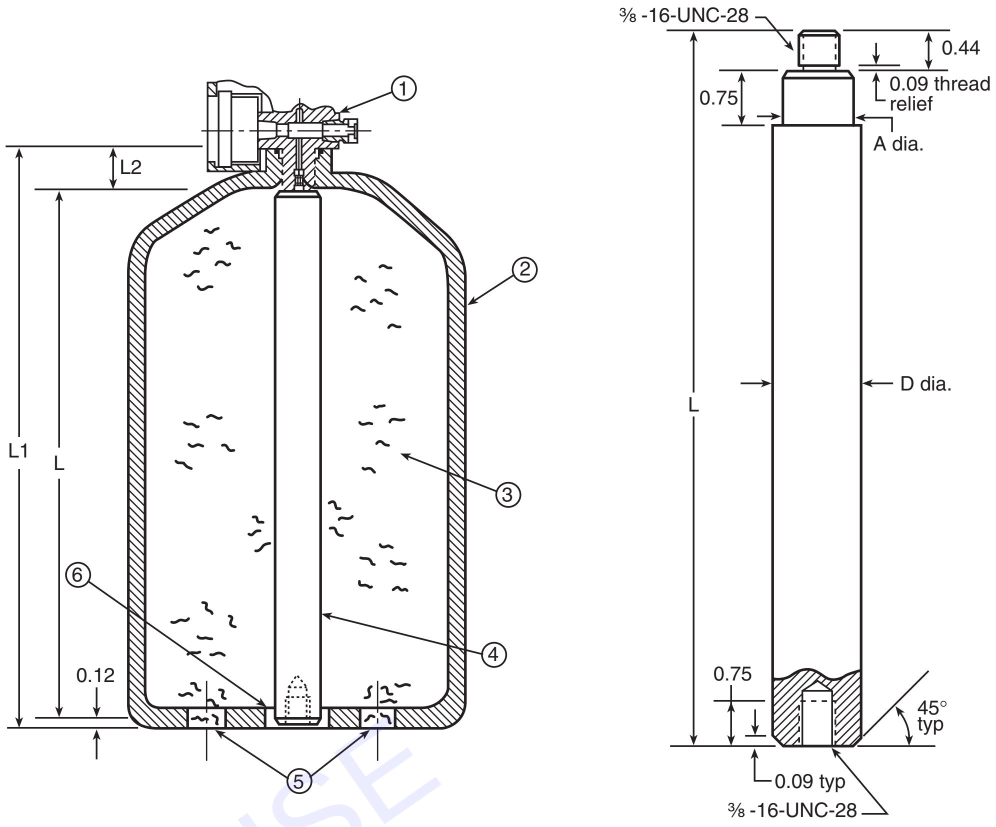
8.3.4.9 The attachment of the cylinder valve shall be permitted to be wrench-tightened prior to the test.

8.3.5 Procedure.

8.3.5.1 The test items shall be placed unrestrained in the compartments specified in 8.3.4.2, and all SCBA adjustment straps shall be fully extended.

FAIR USE

Item	*Description*	*Quantity*
1	Cylinder valve assembly w/gauge and guards, etc.	1
2	SCBA air storage cylinder	1
3	Stepanfoam RI-9619 polyurethane foam system	A/R
4	Ballast rod — ASTM B16 brass, ½ hard	A/R
5	Fill/vent holes ¾ – ⅞ inch diameter	2
6	Ballast rod installation hole — diameter A/R	1



Complete Surrogate Cylinder

Ballast Rod Detail

FIGURE 8.3.4.7 Surrogate Cylinder.

8.3.5.2 No tie-downs shall be allowed to be made to the SCBA.

8.3.5.3 The basic movement of the bed of the test table shall be a 25 mm (1 in.) orbital path, such as can be obtained on a standard package tester operating in synchronous mode at 250 rpm, ±5 rpm.

8.3.5.4 The test duration shall be 3 hours.

8.3.5.5 After being subjected to the vibration test, the SCBA shall be reattached to the breathing air cylinder originally provided with the SCBA and shall then be tested as specified in Section 8.1, Air Flow Performance Test.

8.3.6 Report.

8.3.6.1 The facepiece peak inhalation pressure and peak exhalation pressure shall be recorded and reported for each test condition.

8.3.6.2 The activation and operation, or failure to activate and operate, of the EOSTI shall be recorded and reported.

8.3.6.3 The activation and identification of HUD visual alert signals shall be recorded and reported.

8.3.7 Interpretation.

8.3.7.1 The peak inhalation and peak exhalation shall be used to determine pass/fail performance for each test procedure.

8.3.7.2 One or more specimens failing this test shall constitute failing performance.

8.3.7.3 Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

8.3.7.4 Failure of the HUD to display the breathing air cylinder content or display the visual alert signal during the test shall constitute failing performance.

8.4 Fabric Flame Tests.

8.4.1 Application.

8.4.1.1 This test method shall apply to each different fabric component of the SCBA.

FAIR USE

8.4.1.2 Modifications for testing fabrics less than 75 mm (3 in.) wide shall be as specified in 8.4.8.

8.4.1.3 Modifications for testing fabrics less than 305 mm (12 in.) long shall be as specified in 8.4.9.

8.4.2 Specimens.

8.4.2.1 Specimens shall consist of a 75 mm × 305 mm (3 in. × 12 in.) rectangle.

8.4.2.2 A total of 10 test specimens shall be cut from a standard production run of the fabric components used in the SCBA.

8.4.3 Specimen Preparation.

8.4.3.1 Five test specimens shall be tested without any conditioning.

8.4.3.2 The remaining five test specimens shall be conditioned by five cycles of washing and drying in accordance with the procedures specified in Machine Cycle 1, Wash Temperature V, Drying Procedure Ai, of AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

8.4.4 Apparatus. The test apparatus specified in ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, shall be used.

8.4.5 Procedure.

8.4.5.1 Specimens shall be tested in accordance with ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test).*

8.4.5.2 Each specimen shall be examined for evidence of melting or ignition to determine pass/fail.

8.4.6 Report.

8.4.6.1 Afterflame time and char length shall be recorded and reported for each specimen.

8.4.6.2 The average afterflame time and char length for each material tested shall be calculated and reported.

8.4.6.3 The afterflame time shall be reported to the nearest 0.2 second and the char length to the nearest 3.2 mm (⅛ in.).

8.4.6.4 Observations of melting or dripping for each specimen shall be reported.

8.4.7 Interpretation.

8.4.7.1 Pass/fail performance shall be based on any observed melting or dripping, the average afterflame time, and the average char length.

8.4.7.2 One or more specimens failing this test shall constitute failing performance.

8.4.8 Specific Requirements for Testing Fabrics Less than 75 mm (3 in.) Wide.

8.4.8.1 If the fabric components are not available in the width specified in 8.4.2.1, the width of the test specimen shall be the width as used on the SCBA, but shall be a minimum of 305 mm (12 in.) long.

8.4.8.2 The test frame in Figure 8.4.8.2 shall be utilized to hold samples not available in the width specified in 8.4.2.1.

8.4.8.3 Testing shall be performed as specified in 8.4.5.

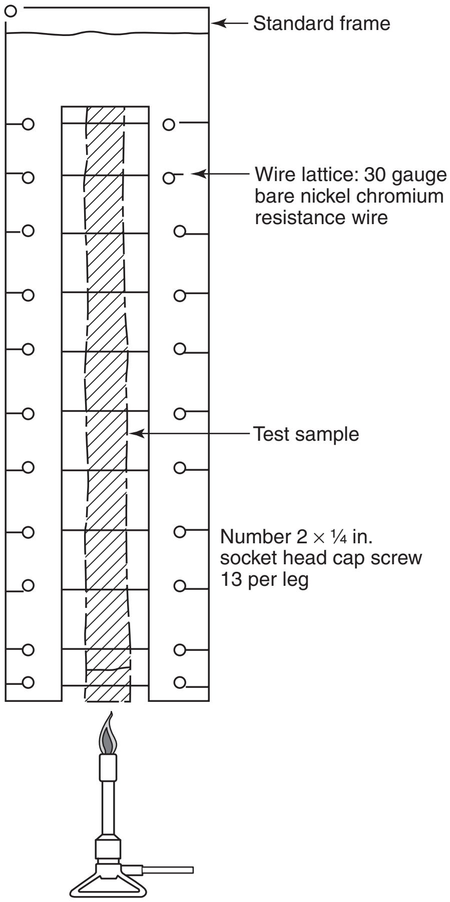

Standard frame
Wire lattice: 30 gauge bare nickel chromium resistance wire
Test sample
Number 2 × ¼ in. socket head cap screw 13 per leg

FIGURE 8.4.8.2 Wire Lattice Test Frame.

8.4.9 Specific Requirements for Testing Fabrics Less than 305 mm (12 in.) Long.

8.4.9.1 Where the fabric components are not available in the length specified in 8.4.2.1, the length of the test specimen shall be the length as used on the SCBA.

8.4.9.2 Samples that are not available in the length required in 8.4.2.1 shall be positioned such that the bottom edge of the sample is positioned at the bottom of the test frame.

8.4.9.3 Testing shall be performed as specified in 8.4.5.

8.5 Fabric Heat Tests.

8.5.1 Application.

8.5.1.1 This test method shall apply to each different fabric component of the SCBA.

8.5.1.2 Modifications for testing fabrics less than 380 mm (15 in.) wide shall be as specified in 8.5.8.

8.5.1.3 Modifications for testing fabrics less than 380 mm (15 in.) long shall be as specified in 8.5.9.

8.5.2 Specimens.

8.5.2.1 Specimens shall consist of a 380 mm × 380 mm (15 in. × 15 in.) square.

8.5.2.2 A total of 10 test specimens shall be cut from a standard production run of the fabric components used in the SCBA.

8.5.3 Specimen Preparation.

8.5.3.1 Five test specimens shall be tested without any conditioning.

8.5.3.2 The remaining five test specimens shall be conditioned by five cycles of washing and drying in accordance with the procedures specified in Machine Cycle 1, Wash Temperature V, Drying Procedure Ai, of AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

8.5.4 Apparatus.

8.5.4.1 The test oven shall be a horizontal flow circulating oven with minimum interior dimensions so that the specimens can be suspended and are at least 50 mm (2 in.) from any interior oven surface or other test specimen.

8.5.4.2 The test oven shall have an air flow rate of 38 m/min to 76 m/min (125 ft/min to 250 ft/min) at the standard temperature and pressure of 21°C (70°F) at 1 atmosphere measured at the center point of the oven.

8.5.4.3 A test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted sample specimen.

8.5.4.3.1 The thermocouple shall be equidistant between the vertical centerline of a mounted specimen placed in the middle of the oven and the oven wall where the air flow enters the test chamber.

8.5.4.3.2 The thermocouple shall be an exposed bead, Type J or Type K, No. 30 AWG thermocouple.

8.5.4.3.3 The test oven shall be heated and the test thermocouple stabilized at 260°C, +6°C or –0°C (500°F, +10°F or –0°F) for a period of not less than 30 minutes.

8.5.5 Procedure.

8.5.5.1 The test specimen shall be suspended by a metal hook(s) at the top and centered in the oven so that the entire test specimen is not less than 50 mm (2 in.) from any oven surface or another test specimen.

8.5.5.2 Oven air flow shall be parallel to the plane of the material.

8.5.5.3 The oven door shall not remain open more than 15 seconds.

8.5.5.3.1 The air circulation shall be shut off while the door is open and turned on when the door is closed.

8.5.5.3.2 The total oven recovery time after the door is closed shall not exceed 30 seconds.

8.5.5.4 The specimen, mounted as specified, shall be exposed in the test oven for 5 minutes, +0.15 minute or –0 minutes.

8.5.5.5 The test exposure time shall begin when the test thermocouple recovers to the temperature of 260°C, +6°C or –0°C (500°F, +10°F or –0°F).

8.5.5.6 Immediately after the specified exposure, the specimen shall be removed and examined for evidence of ignition or melting.

8.5.6 Report. Observations of ignition or melting shall be recorded and reported for each specimen.

8.5.7 Interpretation. Any evidence of ignition or melting on any specimen shall constitute failing performance.

8.5.8 Specific Requirements for Testing Fabrics Less than 75 mm (3 in.) Wide.

8.5.8.1 If the fabric components are not available in the width specified in 8.5.2.1, the width of the test specimen shall be the width as used on the SCBA, but shall be a minimum of 380 mm (15 in.) long.

8.5.8.2 Testing shall be performed as specified in 8.5.5.

8.5.9 Specific Requirements for Testing Fabrics Less than 380 mm (15 in.) Long.

8.5.9.1 If the fabric components are not available in the length specified in 8.5.2.1, the length of the test specimen shall be the length as used on the SCBA.

8.5.9.2 Testing shall be performed as specified in 8.5.5.

8.6 Thread Heat Test.

8.6.1 Application. This test shall apply to sewing thread used in construction of the SCBA.

8.6.2 Specimens. Three 3-mg to 4-mg specimens shall be tested.

8.6.3 Specimen Preparation. Specimens shall be conditioned at 22°C, ±3°C (72°F, ±5°F) with a relative humidity of 50 percent, ±25 percent for a minimum of 4 hours prior to testing.

8.6.4 Apparatus.

8.6.4.1 An electrically heated stage having a circular depression large enough to insert a micro cover glass and a variable transformer controlling the rate of heat input to the stage shall be used.

8.6.4.2 Two armored stem thermometers shall be used, one with a range of 20°C to 160°C (68°F to 320°F), accurate to ½°C (1°F) and one with a range from 150°C to 300°C (302°F to 572°F), accurate to 1°C (2°F).

8.6.4.3 The following items shall be provided for test equipment:

(1) Low-powered magnifying glass
(2) Two micro cover glasses
(3) Spatula, pick needle, or other instrument for applying pressure to the cover glass
(4) Soxhlet extraction apparatus
(5) Chloroform, U.S.P. reagent

8.6.5 Procedure.

8.6.5.1 Specimens shall be extracted with chloroform for a minimum of 20 extractions in a Soxhlet extractor, or equivalent, and dried.

8.6.5.2 The specimen shall then be cut into lengths of 2 mm (1⁄16 in.) or less.

8.6.5.3 The specimen shall be placed in a small mound on a cover glass and covered with another cover glass.

8.6.5.4 The two cover glasses shall be pressed together gently but firmly and placed in the circular depression on the stage.

FAIR USE

8.6.5.5 The temperature of the stage shall be raised with some rapidity to 245°C (473°F) and thereafter at a rate of 3°C to 4°C (5°F to 8°F) per minute until 260°C (500°F) is reached.

8.6.5.6 At this rate of temperature rise, a slight pressure shall be applied on the upper glass cover by pressing with a spatula, pick needle, or other instrument, so that the complete fiber is in contact with the cover glass.

8.6.5.7 The specimen shall be observed with the aid of a magnifying glass at 260°C (500°F).

8.6.6 Report. Observations of any melting of the specimens shall be recorded and reported.

8.6.7 Interpretation. Any specimen exhibiting melting at 260°C (500°F) shall constitute failure of this test.

8.7 Accelerated Corrosion Test.

8.7.1 Application. This test method shall apply to complete SCBA.

8.7.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.7.3 Specimen Preparation.

8.7.3.1 Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), RH 50 percent, ±25 percent.

8.7.3.2 Specimens for conditioning shall be complete SCBA.

8.7.4 Apparatus. A salt fog chamber shall be used for testing and shall meet the requirements of Section 4 of ASTM B 117, *Standard Test Method for Salt Spray (Fog) Testing*.

8.7.5 Procedure.

8.7.5.1 The SCBA with a fully charged breathing air cylinder, with the breathing air cylinder valve fully closed, shall be placed in the test chamber attached to a mannequin to simulate its typical wearing position on a fire fighter as specified by the manufacturer.

8.7.5.2 SCBA shall not contact each other or the sides of the test chamber.

8.7.5.3 The SCBA shall be placed in the temperature stabilized chamber for a minimum of 2 hours prior to introduction of the salt solution.

8.7.5.4 The SCBA shall then be exposed to the salt fog for 48 hours, +15 minutes or –0 minutes.

8.7.5.5 Specimen SCBA shall be subjected to a 5 percent, ±1 percent, salt solution fog.

8.7.5.5.1 The salt solution shall be prepared by dissolving 5 parts, ±1 part by mass of sodium chloride in 95 parts of water.

8.7.5.5.2 The salt used shall be sodium chloride substantially free of nickel and copper and containing on the dry basis not more than 0.1 percent of sodium iodide and not more than 0.3 percent of total impurities.

8.7.5.5.3 The pH of the salt solution shall be in the range of 6.5 to 7.2.

8.7.5.6 The compressed air supply to the nozzle or nozzles for atomizing the salt solution shall be free of oil and dirt and maintained between 69 kPa/m and 172 kPa/m (10 psi and 25 psi).

8.7.5.7 The exposure temperature in the chamber shall be maintained at 35°C ±1°C (95°F ±2°F) for the duration of the test.

8.7.5.8 At least two clean fog collectors shall be placed within the exposure zone so that no drops of solution from the test specimens or any other source shall be collected in them.

8.7.5.8.1 The collectors shall be placed in the proximity of the test specimens, one nearest to any nozzle and the other farthest from all nozzles.

8.7.5.8.2 The fog shall be such that for each 80 cm^2 (12.4 $in.^2$) of horizontal collecting area there will be collected in each collector from 1.0 mL to 2.0 mL of solution per hour.

8.7.5.9 After completion of the salt fog exposure, the SCBA shall then be stored in an environment of 22°C, ±3°C (72°F, ±5°F) at 50 percent, ±5 percent relative humidity for a minimum of 48 hours.

8.7.5.10 The SCBA shall then be tested as specified in Section 8.1, Air Flow Performance Test, to determine pass/fail.

8.7.5.11 All controls or operating features of the SCBA shall operate per the SCBA manufacturer's instructions to determine pass/fail.

8.7.6 Report.

8.7.6.1 The facepiece pressure peak inhalation and peak exhalation shall be recorded and reported for each test condition.

8.7.6.2 The activation and operation, or failure to activate and operate, of the EOSTI shall be reported and recorded.

8.7.6.3 The activation and identification of HUD visual alert signals shall be reported and recorded.

8.7.7 Interpretation.

8.7.7.1 The peak inhalation and peak exhalation shall be used to determine pass/fail performance.

8.7.7.2 One or more specimens failing this test shall constitute failing performance.

8.7.7.3 Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

8.7.7.4 Failure of the HUD to display the breathing air cylinder content or display the visual alert signal during the test shall constitute failing performance.

8.8 Particulate Test.

8.8.1 Application. This test method shall apply to complete SCBA.

8.8.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.8.3 Specimen Preparation.

8.8.3.1 Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), RH 50 percent, ±25 percent.

8.8.3.2 Specimens for conditioning shall be complete SCBA.

8.8.4 Apparatus.

8.8.4.1 The test headform specified in 8.1.4.1 shall be joined to a mannequin to simulate its typical wearing position, as specified by the manufacturer.

FAIR USE

8.8.4.2 The test headform shall be connected, as specified in Section 8.1, Air Flow Performance Test, to the breathing machine specified in 8.1.4.9 or other respiration simulator producing a minute volume of 40 L, ±2 L at the ambient conditions specified in 8.1.3.2, with a minimum tidal volume of 1.6 L per breath at a minimum respiration of 10 breaths per minute.

8.8.4.3 A test facility consisting of a chamber and accessories to control dust concentration, velocity, temperature, and humidity of dust-laden air shall be used.

8.8.4.4 In order to provide adequate circulation of the dust-laden air, no more than 50 percent of the cross-sectional area and 30 percent of the volume of the test chamber shall be occupied by the test item(s).

8.8.4.5* The chamber shall be provided with a means of maintaining and verifying the dust circulation.

8.8.4.6 The dust-laden air shall be introduced into the test space in such a manner as to allow the air to become laminar in flow before it strikes the test item.

8.8.4.7* Dust shall be silica flour and shall contain 97 percent to 99 percent by weight silicon dioxide (SiO_2).

8.8.4.8 The following size distribution shall apply:

(1) 100 percent shall pass through a 100 mesh screen.
(2) 98 percent, ±2 percent shall pass through a 140 mesh screen.
(3) 90 percent, ±2 percent shall pass through a 200 mesh screen.
(4) 75 percent, ±2 percent shall pass through a 325 mesh screen.

8.8.5 Procedure.

8.8.5.1 A fully charged SCBA shall be secured to a test headform and mannequin as specified in 8.8.4.1.

8.8.5.2 The mannequin, including the test headform, shall be mounted upright and placed inside the test chamber.

8.8.5.3 The temperature of the test chamber shall be adjusted to 22°C, ±3°C (72°F, ±5°F) and the relative humidity to less than 30 percent.

8.8.5.4 The air velocity shall be adjusted to 530 m/min, ±15 m/min (1750 ft/min, ±50 ft/min).

8.8.5.5 The dust concentration for the blowing dust shall be maintained at 10.6 g/m^3, ±7 g/m^3 (0.3 g/ft^3, ±0.2 g/ft^3).

8.8.5.6 The test duration shall be 1 hour, and the breathing machine shall be operating throughout the entire test.

8.8.5.6.1 The test shall be permitted to be interrupted to change the SCBA breathing gas cylinder.

8.8.5.6.2 Test item configuration and orientation shall be turned around its vertical axis 180 degrees midway through the test.

8.8.5.7 After the completion of the test, the SCBA shall be removed from the test compartment.

8.8.5.8 The SCBA shall be lightly shaken or brushed free of dust and then shall be tested as specified in Section 8.1, Air Flow Performance Test, to determine pass/fail.

8.8.6 Report.

8.8.6.1 The facepiece pressure peak inhalation and peak exhalation shall be recorded and reported for each test condition.

8.8.6.2 The activation and operation, or failure to activate and operate, of both EOSTI shall be recorded and reported.

8.8.6.3 The activation and identification of HUD visual alert signals shall be recorded and reported.

8.8.7 Interpretation.

8.8.7.1 The peak inhalation and peak exhalation shall be used to determine pass/fail performance.

8.8.7.2 One or more specimens failing this test shall constitute failing performance.

8.8.7.3 Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

8.8.7.4 Failure of the HUD to display the breathing air cylinder content or display the visual alert signal during the test shall constitute failing performance.

8.9 Facepiece Lens Abrasion Test.

8.9.1 Application. This test method shall apply to facepiece lenses.

8.9.2 Samples. A minimum of four faceshield lenses shall be tested.

8.9.3 Specimen Preparation.

8.9.3.1 Seven specimens shall be chosen from a minimum of four facepiece lenses.

8.9.3.1.1 Four specimens shall be taken from the left viewing area, and three samples shall be taken from the right viewing area.

8.9.3.1.2 One of the four specimens taken from the left viewing area shall be the set-up specimen.

8.9.3.2 The left test specimens shall conform to all of the following criteria:

(1) The specimen shall be a square measuring 50 mm × 50 mm (2 in. × 2 in.).
(2) Two edges of the square section shall be parallel within ±2 degrees of the axis of the cylinder or cone in the center of the specimen.
(3) At least 38 mm (1½ in.) of the 50 mm × 50 mm (2 in. × 2 in.) square shall be taken from the left side of the center line of the lens.
(4) The 50 mm × 50 mm (2 in. × 2 in.) square shall be cut at approximately eye level.

8.9.3.3 The right test specimens shall include all of the following criteria:

(1) The specimen shall be a square measuring 50 mm × 50 mm (2 in. × 2 in.).
(2) Two edges of the square section shall be parallel within ±2 degrees of the axis of the cylinder or cone in the center of the specimen.
(3) At least 38 mm (1½ in.) of the 50 mm × 50 mm (2 in. × 2 in.) square shall be taken from the right side of the center line of the lens.
(4) The 50 mm × 50 mm (2 in. × 2 in.) square shall be cut at approximately eye level.

8.9.3.4 Each of the specimens shall be cleaned in the following manner:

(1) The specimen shall be rinsed with clean tap water.
(2) The specimen shall be washed with a solution of nonionic/low-phosphate detergent and water using a clean, soft gauze pad.
(3) The specimen shall be rinsed with de-ionized water.
(4) The specimen shall be blown dry with clean compressed air or nitrogen.

8.9.4 Apparatus. The test apparatus shall be constructed in accordance with Figure 8.9.4(a) and Figure 8.9.4(b).

8.9.5 Procedure.

8.9.5.1 The haze of the specimen shall be measured using a haze meter in accordance with ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics,* and recorded with the following additions:

(1) The haze shall be measured in the middle of the specimen ±1.6 mm (±1⁄16 in.).
(2) The specimen shall be repositioned to achieve the maximum haze value within the area defined in (1).
(3) The haze meter shall have a specified aperture of 22.4 mm (7⁄8 in.).
(4) The haze meter shall have a visual display showing 0.1 percent resolution.
(5) The haze meter shall be calibrated before and after each day's use following procedures specified in ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.*

8.9.5.2 The set-up specimen shall be placed cover side up in the test apparatus specimen holder.

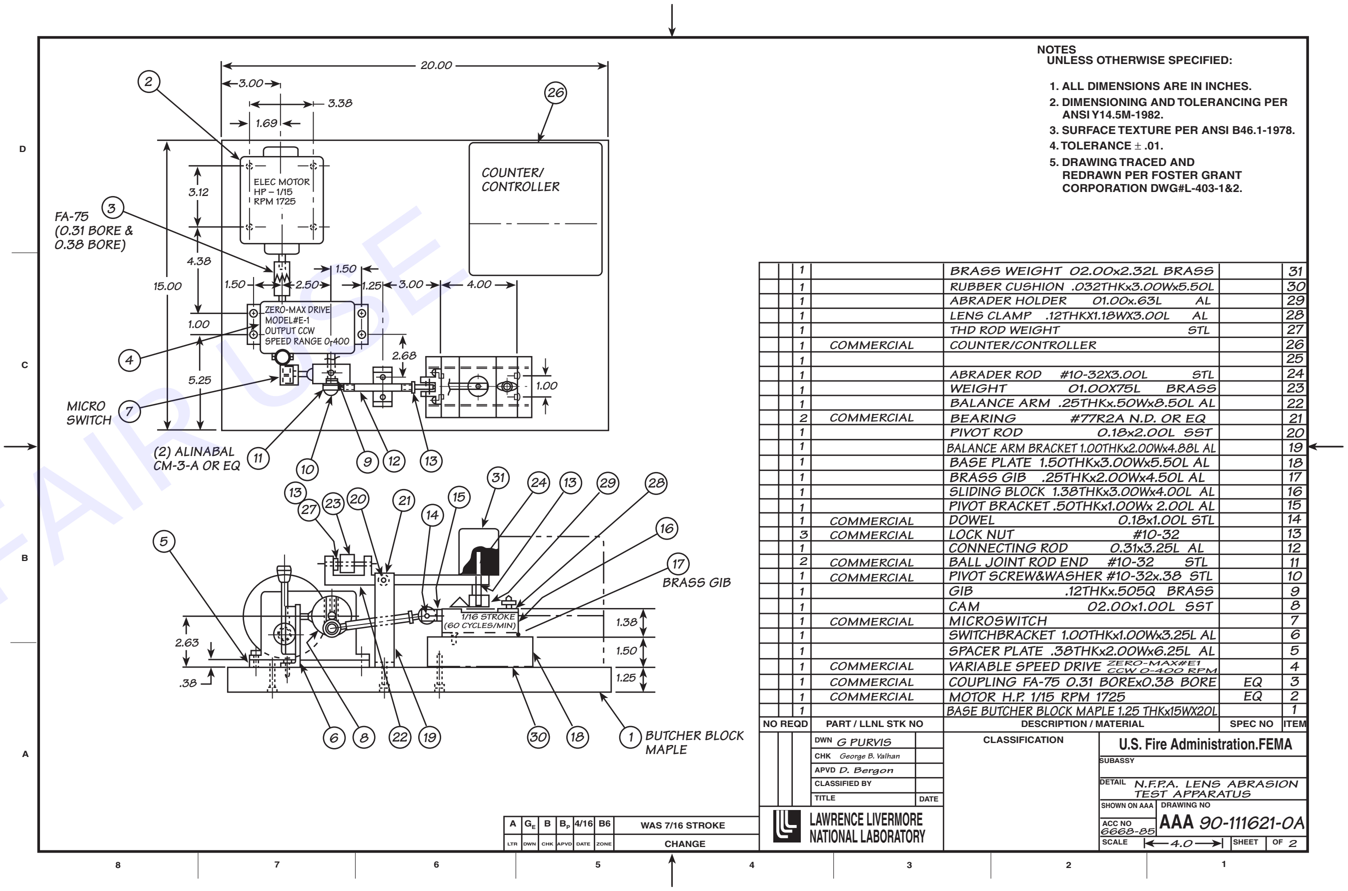
8.9.5.3 The specimen holder shall be configured with a flat surface under the lens or with an inner radius support.

8.9.5.4 The pad holder shall consist of a cylinder 10 mm (3⁄8 in.) high and 25 mm (1 in.) in diameter with a radius of curvature equal to the radius of curvature of the outside of the lens in the viewing area ±0.25 diopter. This cylinder shall be rigidly affixed to the stroking arm by a #10-32 UNF threaded rod.

8.9.5.5 The pad shall be a Blue Streak M306M wool felt polishing pad or equivalent, 24 mm (15⁄16 in.) in diameter.

8.9.5.6 The abrasive disc shall be made from 3M Part Number 7415, Wood Finishing Pad or equivalent.

8.9.5.6.1 A disc, 24 mm (15⁄16 in.) in diameter, shall be cut from the abrasive sheet.



NOTES
UNLESS OTHERWISE SPECIFIED:

1. ALL DIMENSIONS ARE IN INCHES.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1978.
4. TOLERANCE ± .01.
5. DRAWING TRACED AND REDRAWN PER FOSTER GRANT CORPORATION DWG#L-403-1&2.

NO REQD	PART / LLNL STK NO	DESCRIPTION / MATERIAL	SPEC NO	ITEM
1		BRASS WEIGHT 02.00x2.32L BRASS		31
1		RUBBER CUSHION .032THKx3.00Wx5.50L		30
1		ABRADER HOLDER 01.00x.63L AL		29
1		LENS CLAMP .12THKX1.18WX3.00L AL		28
1		THD ROD WEIGHT STL		27
1	COMMERCIAL	COUNTER/CONTROLLER		26
1				25
1		ABRADER ROD #10-32X3.00L STL		24
1		WEIGHT 01.00X75L BRASS		23
1		BALANCE ARM .25THKx.50Wx8.50L AL		22
2	COMMERCIAL	BEARING #77R2A N.D. OR EQ		21
1		PIVOT ROD 0.18x2.00L SST		20
1		BALANCE ARM BRACKET 1.00THKx2.00Wx4.88L AL		19
1		BASE PLATE 1.50THKx3.00Wx5.50L AL		18
1		BRASS GIB .25THKx2.00Wx4.50L AL		17
1		SLIDING BLOCK 1.38THKx3.00Wx4.00L AL		16
1		PIVOT BRACKET .50THKx1.00Wx 2.00L AL		15
1	COMMERCIAL	DOWEL 0.18x1.00L STL		14
3	COMMERCIAL	LOCK NUT #10-32		13
1		CONNECTING ROD 0.31x3.25L AL		12
2	COMMERCIAL	BALL JOINT ROD END #10-32 STL		11
1	COMMERCIAL	PIVOT SCREW&WASHER #10-32x.38 STL		10
1		GIB .12THKx.505Q BRASS		9
1		CAM 02.00x1.00L SST		8
1	COMMERCIAL	MICROSWITCH		7
1		SWITCHBRACKET 1.00THKx1.00Wx3.25L AL		6
1		SPACER PLATE .38THKx2.00Wx6.25L AL		5
1	COMMERCIAL	VARIABLE SPEED DRIVE ZERO-MAX#E1 CCW 0-400 RPM		4
1	COMMERCIAL	COUPLING FA-75 0.31 BOREx0.38 BORE	EQ	3
1	COMMERCIAL	MOTOR H.P. 1/15 RPM 1725	EQ	2
1		BASE BUTCHER BLOCK MAPLE 1.25 THKx15WX20L		1

DWN G PURVIS
CHK George B. Valhan
APVD D. Bergon
CLASSIFIED BY
TITLE
DATE
CLASSIFICATION
U.S. Fire Administration.FEMA
SUBASSY
DETAIL N.F.P.A. LENS ABRASION TEST APPARATUS
SHOWN ON AAA
DRAWING NO AAA 90-111621-0A
ACC NO 6668-85
SCALE 4.0
SHEET
OF 2
LAWRENCE LIVERMORE NATIONAL LABORATORY

LTR	DWN	CHK	APVD	DATE	ZONE	CHANGE
A	G_E	B	B_P	4/16	B6	WAS 7/16 STROKE

FIGURE 8.9.4(a) Lens Abrasion Tester.

FAIR USE

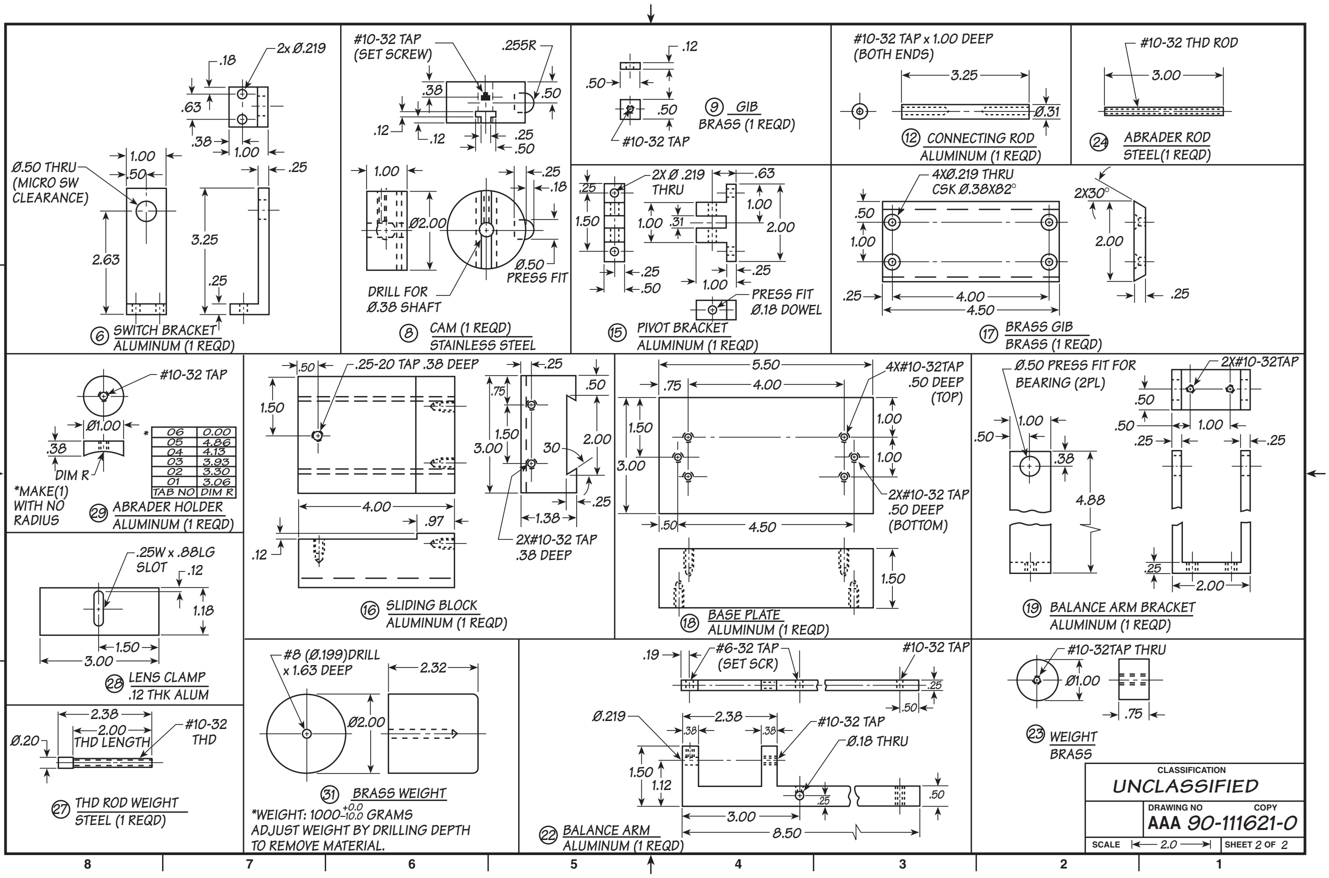


FIGURE 8.9.4(b) Lens Abration Tester (details).

8.9.5.6.2 The marked side of the disc shall be placed against the pad.

8.9.5.6.3 Care shall be exercised to maintain the orientation described in 8.9.5.6.2 for each abrasive disc throughout the testing.

8.9.5.7 The pad holder, pad, and abrasive disc shall be installed on the stroking arm.

8.9.5.7.1 The stroking arm shall be leveled to ±3 degrees by adjusting the threaded pin.

8.9.5.7.2 The pin shall be secured to prevent rotation of the pad holder.

8.9.5.7.3 The axis of curvature of the pad holder shall be coincident with the axis of curvature of the lens.

8.9.5.8 The stroking arm shall be counterbalanced with the pad holder, pad, and abrasive disc in place.

8.9.5.9 The set-up specimen shall be replaced with one of the six specimens to be tested.

8.9.5.10 The 1000 g, ±5 g (2.2 lb, ±0.18 lb) test weight shall be installed on the pin above the test specimen.

8.9.5.11 The test shall be run for 200 cycles, ±1 cycle. One cycle shall consist of a complete revolution of the eccentric wheel.

8.9.5.12 The length of stroke shall be 14.5 mm (9/16 in.), producing a pattern 38 mm (1½ in.) long.

8.9.5.12.1 The frequency of the stroke shall be 60 cycles, ±1 cycle, per minute.

8.9.5.12.2 The center of the stroke shall be within ±2 mm (±1/16 in.) of the center of the specimen.

8.9.5.13 The specimen shall be removed and cleaned following the procedure specified in 8.9.3.4.

8.9.5.14 The abrasive disc shall be discarded.

8.9.5.15 The haze of the specimen shall be measured following the procedure specified in 8.9.5.1.

8.9.5.16 The delta haze shall be calculated by subtracting the initial haze from the final haze.

8.9.5.17 The testing steps specified in 8.9.3.4 through 8.9.5.16 shall be repeated five times with a new specimen and abrasive disc.

8.9.6 Report.

8.9.6.1 The six delta haze values shall be recorded and the values shall be averaged and reported.

8.9.6.2 The average value shall be used to determine pass/fail.

FAIR USE

8.9.7 Interpretation.

8.9.7.1 The average delta haze shall be used to determine pass/fail performance.

8.9.7.2 Failure of the average value shall constitute failure for the entire sample.

8.10 Communication Test.

8.10.1 Application. This test method shall apply to complete SCBA.

8.10.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.10.3 Specimen Preparation.

8.10.3.1 Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), RH 50 percent, ±25 percent.

8.10.3.2 Specimens for conditioning shall be complete SCBA.

8.10.4 Apparatus.

8.10.4.1 Testing shall be conducted in a chamber that absorbs a minimum of 90 percent of all sound from 500 Hz to 5000 Hz.

8.10.4.2 Five listening subjects and five talkers consisting of four males and one female shall be available for testing.

8.10.4.3 The subjects participating as listeners shall have “audiometrically normal” hearing as defined in Section 5.3 of ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems,* in the range of 500 Hz to 3000 Hz.

8.10.4.4 Talkers and listeners shall be selected and trained according to Section 7 of ANSI S3.2, *Method for Measuring the Intelligibility of Speech Over Communication Systems.*

8.10.4.5 The five talkers shall not have facial hair, any unusual facial characteristics, or any other condition that could cause interference with the seal of the facepiece.

8.10.4.6 The talkers shall perform and pass a qualitative facepiece-to-face fit check per the SCBA manufacturer’s instructions.

8.10.4.7 Where the talker is qualified to wear several sizes of facepieces, then the talker shall choose the facepiece that is most comfortable.

8.10.4.8 The five talkers shall be trained in the donning and usage of the SCBA per manufacturer’s instructions.

8.10.4.9 The five talkers shall have no obvious speech defect or strong regional accent.

8.10.4.10 Distance between the talker and listener(s) shall be 1.5 m, +305 mm or –0 mm (5 ft, +1ft or –0 ft), and they shall be facing each other.

8.10.4.11 The test chamber shall be filled with broadband “pink” noise with a tolerance of 6 dB per octave band from 400 Hz to 4000 Hz.

8.10.4.12 The forward axis of the loudspeaker shall be oriented away from the listener group.

8.10.4.13 The distance between the loudspeaker and the listeners shall be as great as possible so as to create a quasi-uniform sound field over the listening group.

8.10.4.14 More than one loudspeaker shall be permitted to be used to achieve the desired sound field.

8.10.4.15 The gain of the power amplifier shall be adjusted to achieve an A-weighted sound level of 70 dB, ±2 dB at each listener’s head position, without listeners present.

8.10.5 Procedure.

8.10.5.1 The method for measuring word intelligibility shall be as specified in ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems,* with the modified apparatus specified in 8.10.4.

8.10.5.2 The test material shall be the reading of one complete list of phonetically balanced words as contained in Table 1 of ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems.*

8.10.5.2.1 The words shall be spoken singularly in the following carrier sentence: “Would you write (list word) now?”

8.10.5.2.2 The rate shall be approximately one test word every 6 seconds.

8.10.5.2.3 The talkers shall be trained to talk at 75 dBA to 85 dBA without an SCBA facepiece, measured at the listener’s ear, placing no unusual stress on any word.

8.10.5.2.4 Training shall include the use of background noise as defined in 8.10.4.11.

8.10.5.2.5 The talkers shall not vary their voice level from that used without the facepiece after the facepiece is donned.

8.10.5.2.6 The listeners shall write each word as they hear it.

8.10.5.3 The talkers shall conduct two tests in the chamber having an ambient noise field as specified in 8.10.4.11, using a different word list for each of the following conditions:

(1) With no SCBA
(2) With SCBA worn and operated per the SCBA manufacturer’s instructions

8.10.5.4 Talkers’ speech shall be recorded during the tests to determine if the talkers conform to the word list specified for that test.

8.10.5.5 Each listener’s response form shall be scored as to the number of correct responses out of the 50 words recited.

8.10.5.5.1 Listeners’ scores shall be based on the words actually spoken by the talkers.

8.10.5.5.2 Listeners’ scores shall not be reduced because of speaking mistakes of the talkers or spelling errors that are phonetically correct.

8.10.5.5.3 All of the listeners’ scores without the SCBA used by the talker shall be averaged and all of the listeners’ scores with the SCBA used by the talker shall be averaged.

8.10.5.5.4 The average score of the five listeners for the talker using the SCBA shall be divided by the average score of the five listeners for the talker without using the SCBA, and the result shall be called the “score value.” This procedure shall be performed for each of the five talkers.

8.10.5.6 The average of the score values obtained in 8.10.5.4.3 and 8.10.5.5.4 shall be calculated.

8.10.5.6.1 Where the average of the score values is >72 percent, this average score value shall be used to determine pass/fail as specified in Section 7.10.

FAIR USE

8.10.5.6.2 Where the average of the score values is <72 percent, the sample standard deviation (*s.d.*) of the score values shall be calculated in the following manner:

$$s.d. = \sqrt{\frac{\Sigma x^2 - \left(\frac{\Sigma x}{N}\right)^2}{N-1}}$$

where:
x = score values
N = sample size (5)

8.10.5.6.3 Where the calculated sample standard deviation of the test score values is >10.0, the test shall be invalidated, and the procedures of 8.10.5.2 through 8.10.5.6.6 shall be repeated.

8.10.5.6.4 Where the calculated sample standard deviation of the test score values is <10.0, a test statistic, *T*-value, shall be calculated to determine if the average of the score values obtained is or is not equivalent to 72 percent; it shall be calculated in the following manner:

$$T = \frac{(\mu - \bar{X})\sqrt{N}}{s.d.}$$

where:
$\bar{X}$ = average of the score values
N = sample size (5)
μ = 72 percent
$s.d.$ = sample standard deviation

8.10.5.6.5 For *T*-values ≤ 2.13, the score value shall be considered to be equivalent to a score value of 72 percent and shall be used to determine pass/fail as specified in Section 7.10.

8.10.5.6.6 For *T*-values > 2.13, the score value shall be as calculated in 8.10.5.6, and this calculated score value shall be used to determine pass/fail as specified in Section 7.10.

8.10.6 Report. The average of the score values obtained shall be recorded and reported.

8.10.7 Interpretation. One or more average score values failing this test shall constitute failing performance.

8.11* Heat and Flame Test.

8.11.1 Application. This test method shall apply to complete SCBA.

8.11.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.11.3 Specimen Preparation.

8.11.3.1 Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), RH 50 percent, ±25 percent.

8.11.3.2 Specimens for conditioning shall be complete SCBA.

8.11.4 Apparatus.

8.11.4.1 A test mannequin meeting the requirements specified in Figure 8.11.4.1 shall be provided.

8.11.4.2* The test mannequin shall have a protective covering that shall be designed and constructed as specified in 8.11.4.2.1 through 8.11.4.2.15.

8.11.4.2.1 The assembled protective covering shall consist of at least an outer shell and a thermal liner and shall have an average thermal protective performance (TPP) of not less than 35.0 when tested in accordance with 5.1.1 of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting.*

8.11.4.2.2 The outer shell shall be one of the following options:

(1) 40 percent PBI®/60 percent Kevlar® ripstop weave, weighing nominally 225 g/m² (7.5 oz/yd²) in a natural and undyed color
(2) 40 percent PBI®/60 percent Kevlar® plain weave, weighing nominally 225 g/m² (7.5 oz/yd²) in a natural and undyed color

8.11.4.2.3 The liner shall be no more than 75 mm (3 in.) from the coat hem.

8.11.4.2.4 The protective covering shall be stitched with Kevlar® thread using 6–8 stitches per 25 mm (1 in.).

8.11.4.2.5 All major seams shall be double stitched with all inside seams to be finished with Kevlar® thread.

8.11.4.2.6 All reinforcements shall be constructed of the outer shell fabric used in 8.11.4.2.2.

8.11.4.2.7 No metal shall pass from the outside of the protective covering through the liner to cause the transfer of heat to the mannequin when the protective covering is completely assembled.

8.11.4.2.8 The protective covering, including the front closure, shall be constructed in a manner that provides secure and complete thermal protection.

8.11.4.2.9 If non-positive fasteners, such as snaps or hook-and-pile tape, are utilized in garment closures, a positive locking fastener, such as hooks and dees or zippers, shall also be utilized.

8.11.4.2.10 Pockets and trim shall not be installed.

8.11.4.2.11 The collar shall be made of the same construction as the body of the protective covering. In addition, there shall be outer shell material both on the back, or outside, and next to the mannequin neck.

8.11.4.2.11.1 No throat strap shall be attached to the covering.

8.11.4.2.12 Sleeve outside seams shall be felled and inside seams shall be lock stitched.

8.11.4.2.13 All protective covers shall measure 890 mm (35 in.) long when measured from the center of the back collar seam to the hem.

8.11.4.2.14 The protective cover size shall be 1120 mm (44 in.) chest, 865 mm (34 in.) sleeve.

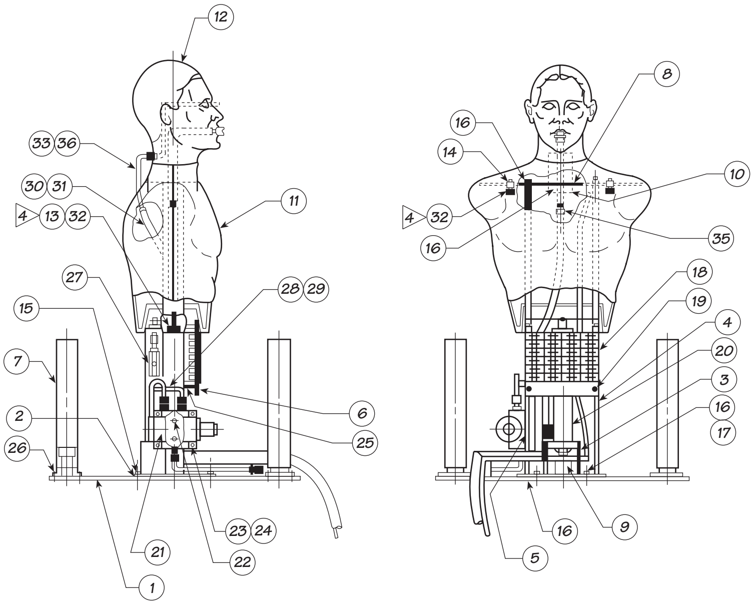
8.11.4.2.15 The complete protective covering shall be discarded and shall not be used after three flame exposures of the flame and heat test.

8.11.4.3 A test headform meeting the requirements specified in 8.1.4.1 shall be used on the test mannequin.

8.11.4.4 The test headform shall be attached to the breathing machine as specified in Figure 8.1.4.13, with the modification that a 38 mm (1½ in.) I.D. breathing hose, not longer than 7.6 m (25 ft), shall be interconnected between the breathing machine and the throat tube of the test mannequin headform.

FAIR USE

NOTES
Unless otherwise specified:
1. All dimensions are in inches.
2. Dimensioning and tolerancing per ANSI Y14.5M–1982.
3. Surface texture per ANSI B46.1–1978.
4 $4 \times 0.197^{+.010}_{-.002}$ THRU ITEM II, MATCH DRILL FROM ITEMS 13 & 14 FOR ITEM 32.



NO REQD	PART/LLNL STK NO	DESCRIPTION/MATERIAL	SPEC NO.	ITEM
A/R		TUBE, S/STL, 1/4 O.D.		36
1		CLAMP, AEROSEAL, 0 1/2		35
1	SWAGELOK-400-6	UNION, 1/4 TUBE CRES		33
12		SCR, #8-32 UNC-2A RD HD X 3/8 LG CRES		32
1		CLAMP, AEROSEAL, 0 1/2 CRES		31
A/R		TUBE, PVC REINFORCED 1/4 I.D.	9330-51405	30
5	SWAGELOK-600-1-2	MALE CONNECTOR, 3/8 TUBE X 1/8 NPT CRES		29
A/R		TUBE, 0.375 X .035 W. CRES	4710-14193	28
1	ARO CORP	SNUBBER		27
12		SCR, 1/4-20 UNC-2A SOC HD X 1.00 LG STL		26
4		STANDOFF, #6-32 THD, X 1.00 LG ALUM	5975-53447	25
4		NUT, HEX, #10-32 UNF-28 STD STL		24
4		SCR, #10-32 UNF-2A SOC HD X 1.50 LG STL		23
4		SCR, #10-32 UNF-2A FLT HD X 1.00 LG STL		22
1	ARO CORP MODEL K21355120A	VALVE		21
1	ARO CORP 0418-1003-080	CYLINDER , AIR, 1 1/8 BORE		20
4		SCR, #6-32 UNC-2A RD HD X 1 1/2 LG STL		19
4	MARLIN CORP. 1032-6	CONNECTOR, T.C., 6 JACK, 2 HOLE, TYPE K	5935-58196	18
		NUT, HEX, 1/4-20 UNC-2B STD STL		17
12		SCR, 1/4-20 UNC-2A FLT HD X .75 LG STL		16
4		SCR, 1/4-20 UNC-2A SOC HD X .50 LG STL		15
4	90-101459	BRACKET		14
2	90-101473 A	TIE STRAP		13
1	90-101456	HEAD		12
1	90-10146 OR 90-101458	TORSO I OR TORSO II		11
1	89-113884	COLLAR-MOUNT		10
1	89-113883	SHAFT END		9
1	89-111724	MOUNT PLATE, MANNEQUIN		8
4	89-113882	GUIDE VERTICAL		7
1	89-113881	T.C. PANEL		6
1	89-113880	VALVE PLATE		5
2	89-113878	FRAME BAR		4
1	89-113877	MOUNT-AIR CYL.		3
1	89-113876	BASE MOUNT		2
1	89-113879	LIFT PLATE		1

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MAJOR UNIT U.S. Fire Administration FEMA
SUBASSY. NFPA HEAT & FLAME TEST APPARATUS
DETAIL MANNEQUIN ASSY
SHOWN ON AAA 3265-30
DRAWING NO AAA 90-101453-0A
SCALE 8.00 SHEET OF

FIGURE 8.11.4.1 Test Mannequin.

FAIR USE

8.11.4.5 The test headform shall be covered with an undyed aramid hood for protection of the headform during testing.

8.11.4.5.1 The protective hood shall meet the hood requirements of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*.

8.11.4.5.2 The protective hood, when placed on the test headform, shall not affect the seal of the facepiece to the headform.

8.11.4.5.3 The protective hood shall not cover or protect any part of the facepiece or the facepiece retention system that holds the facepiece to the headform.

8.11.4.6 The heat and flame test apparatus shall be as specified in Figure 8.11.4.6.

8.11.4.6.1 The test oven shall be a horizontal forced circulating air oven with an internal velocity of 61 m/min (200 ft/min).

8.11.4.6.2 The test oven shall have minimum dimensions of 915 mm depth × 915 mm width × 1.22 m height (36 in. depth × 36 in. width × 48 in. height).

8.11.5 Procedure.

8.11.5.1 The SCBA shall be mounted on the test mannequin to simulate the correct wearing position on a person as specified by the SCBA manufacturer's instructions.

8.11.5.2 The facepiece shall be mounted and tested on the test headform as specified in 8.1.4.1.

8.11.5.3 The test oven shall be calibrated using a 30-gauge exposed bead type-J iron/constantan wire reference thermocouple that has been calibrated to set the 0.0°C (32.0°F) reference point with an ice bath containing ice and de-ionized or distilled water.

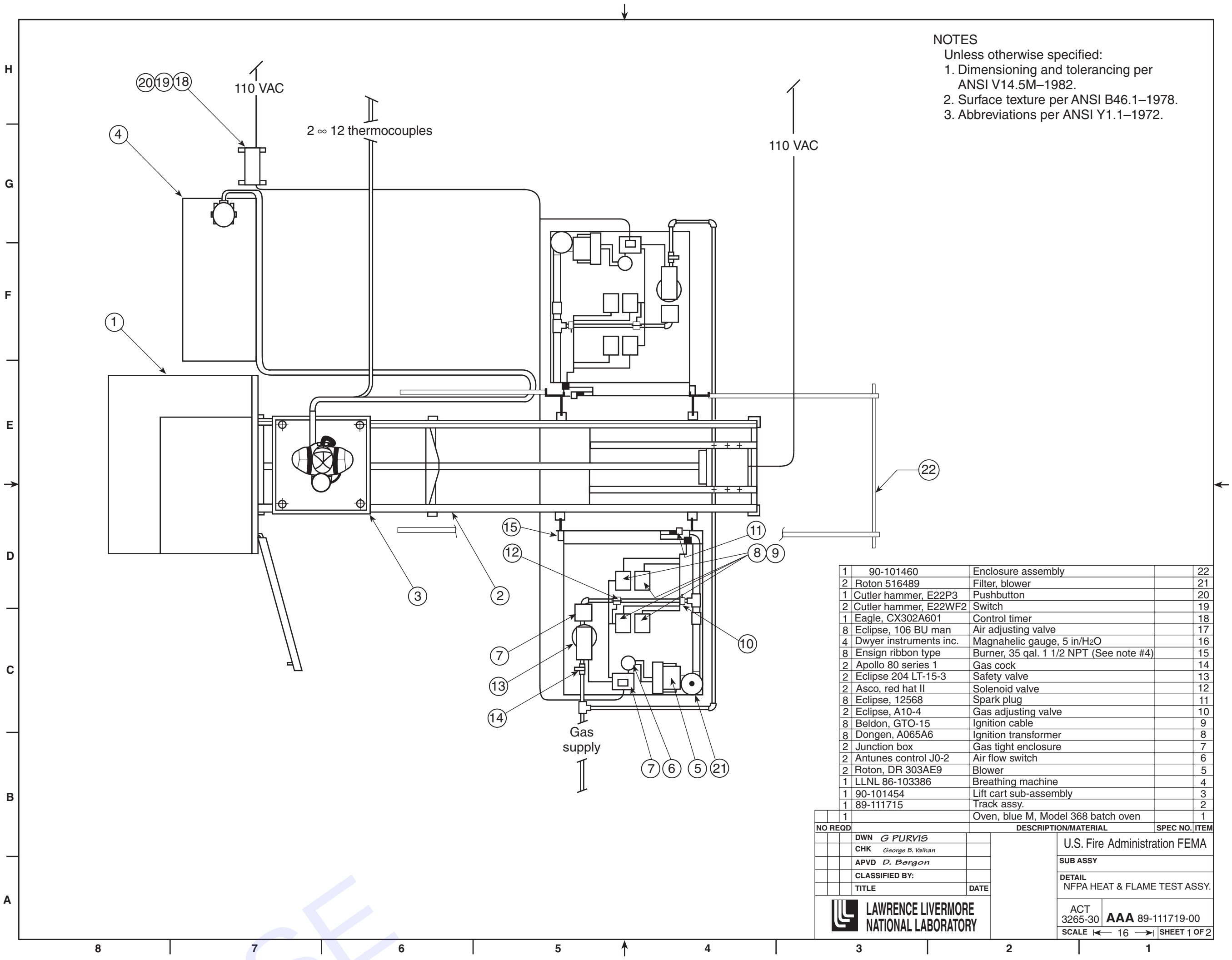
8.11.5.3.1 Boiling water shall be used to set the 100°C (212°F) reference value.

8.11.5.3.2 The reference temperatures shall be corrected to standard temperatures using a barometric pressure correction.

8.11.5.4 For calibration prior to the heat and flame test, the mannequin for calibration shall be the same as the test mannequin specified in 8.11.4.1 and shall be exposed to direct flame contact for 10 seconds using the heat and flame test apparatus.

8.11.5.4.1 All peak temperature readings shall be within a temperature range of 815°C to 1150°C (1500°F to 2102°F). The average mean of all peak temperature readings shall be no higher than 950°C (1742°F).

8.11.5.5 The test oven recovery time, after the door is closed, shall not exceed 1.0 minute.



NOTES
Unless otherwise specified:
1. Dimensioning and tolerancing per ANSI V14.5M–1982.
2. Surface texture per ANSI B46.1–1978.
3. Abbreviations per ANSI Y1.1–1972.

NO REQD		DESCRIPTION/MATERIAL	SPEC NO.	ITEM
1	90-101460	Enclosure assembly		22
2	Roton 516489	Filter, blower		21
1	Cutler hammer, E22P3	Pushbutton		20
2	Cutler hammer, E22WF2	Switch		19
1	Eagle, CX302A601	Control timer		18
8	Eclipse, 106 BU man	Air adjusting valve		17
4	Dwyer instruments inc.	Magnahelic gauge, 5 in/H_2O		16
8	Ensign ribbon type	Burner, 35 qal. 1 1/2 NPT (See note #4)		15
2	Apollo 80 series 1	Gas cock		14
2	Eclipse 204 LT-15-3	Safety valve		13
2	Asco, red hat II	Solenoid valve		12
8	Eclipse, 12568	Spark plug		11
2	Eclipse, A10-4	Gas adjusting valve		10
8	Beldon, GTO-15	Ignition cable		9
8	Dongen, A065A6	Ignition transformer		8
2	Junction box	Gas tight enclosure		7
2	Antunes control J0-2	Air flow switch		6
2	Roton, DR 303AE9	Blower		5
1	LLNL 86-103386	Breathing machine		4
1	90-101454	Lift cart sub-assembly		3
1	89-111715	Track assy.		2
1		Oven, blue M, Model 368 batch oven		1

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TITLE DATE
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DETAIL NFPA HEAT & FLAME TEST ASSY.
ACT 3265-30 AAA 89-111719-00
SCALE 16 SHEET 1 OF 2

FIGURE 8.11.4.6 Heat and Flame Test Apparatus.

FAIR USE

8.11.5.6 The air flow performance test shall be conducted as specified in 8.1.5, with modifications to the ventilation rate specified in 8.11.5.8 with test temperatures specified in 8.11.5.4 and 8.11.5.9.

8.11.5.6.1 The variation in pressure extremes caused by the heat and flame test mannequin configuration shall be determined in the following manner. The air flow performance test as specified in Section 8.1, Air Flow Performance Test, shall be carried out using the configuration specified in 8.11.4.4 at the same ventilation rates. The difference in pressure between the two tests shall be calculated by subtracting the values obtained using the configuration defined in 8.11.4.4 from the values obtained using the configuration specified in Section 8.1, Air Flow Performance Test.

8.11.5.7 The air flow performance test shall continue through the drop test as specified in 8.11.5.16.

8.11.5.8 The ventilation rate shall be set at 40 L/min, ±2 L/min, with a respiratory frequency of 12 breaths/min, ±1 breath/min, at ambient conditions as specified in 8.1.3.2.

8.11.5.9 The SCBA mounted on the test mannequin shall be placed in the test oven that has been preheated to 95°C, ±2°C (203°F, ±4°F).

8.11.5.10 After the test oven door is closed and the oven temperature recovers to 95°C (203°F), the test exposure time of 15 minutes shall begin.

8.11.5.11 At the completion of the 15-minute exposure, the ventilation rate shall be increased to 103 L/min, ±3 L/min, as specified in 8.1.4.10.7.

8.11.5.12 The oven door shall be opened and the SCBA mounted on the test mannequin shall be moved out of the oven and into the center of the burner array.

8.11.5.13 The SCBA shall then be exposed to direct flame contact for 10 seconds, +0.25 second or –0.0 seconds.

8.11.5.14 This exposure shall begin within 20 seconds of removal of the SCBA from the test oven.

8.11.5.15 The SCBA shall be observed for any afterflame, and the afterflame duration shall be recorded to determine pass/fail as specified in 7.11.2.

8.11.5.16 Within 20 seconds after completing the direct flame exposure, the SCBA mounted on the test mannequin shall be raised 150 mm, +6 mm or −0 mm (6 in., +¼ in. or −0 in.) and dropped freely.

8.11.5.17 The SCBA shall be observed to determine pass/fail as specified in 7.11.3.

8.11.5.18 The facepiece pressure during the entire test shall be read from the strip chart recorder and corrected by adding the value of the difference in pressure calculated in 8.11.5.6.1 to determine pass/fail as specified in 7.11.1.

8.11.5.19 Any pressure spike caused by the impact of the drop test and measured within a duration of three cycles of the breathing machine after the apparatus drop shall be disregarded.

8.11.5.20 The SCBA facepiece and HUD shall be removed from the test headform and shall be donned by a test subject without touching the facepiece lens or HUD.

8.11.5.20.1 The test subject shall have visual acuity of 20/20 in each eye, uncorrected or corrected with contact lenses.

8.11.5.20.2 The test subject shall then observe the HUD display to see that visual alert signal(s) have activated.

8.11.5.20.3 The test subject shall identify the visual alert signals that are activated.

8.11.5.21 The SCBA facepiece, removed from the test headform and donned by the test subject as specified in 8.11.5.20, shall be used for determining facepiece lens vision.

8.11.5.21.1 The test shall be conducted using a standard 6.1 m (20 ft) eye chart with normal lighting range of 120 to 150 ft-candles at the chart and with the test subject positioned at a distance of 6.1 m (20 ft) from the chart.

8.11.5.21.2 The test subject shall then read the standard eye chart at some point through the nominal center of the lens of the facepiece to determine pass/fail as specified in 7.11.4.

8.11.5.21.3 The nominal center of the lens shall be the area bounded by a line 50 mm (2 in.) above, 50 mm (2 in.) below, 50 mm (2 in.) left, and 50 mm (2 in.) right of the intersection of the basic and midsagittal planes.

8.11.5.22 The activation of the EOSTI shall be observed.

8.11.6 Report.

8.11.6.1 The facepiece pressure peak inhalation and peak exhalation shall be recorded and reported for each test condition.

8.11.6.2 Any afterflame beyond 2.2 seconds shall be recorded and reported.

8.11.6.3 The facepiece lens vision shall also be recorded and reported.

8.11.6.4 The activation and operation, or failure to activate and operate, of EOSTI shall be recorded and reported.

8.11.6.5 The activation and identification of HUD visual alert signals shall be recorded and reported.

8.11.7 Interpretation.

8.11.7.1 Pass/fail performance shall be based on any observed afterflame, the peak inhalation and exhalation values, and the facepiece vision value.

8.11.7.2 Failure to meet any of the test condition requirements shall constitute failure of the SCBA.

8.11.7.3 Failure of any EOSTI alarm signals to activate and remain active during the test shall constitute failing performance.

8.11.7.4 Failure of the HUD to display the breathing air cylinder content or display the visual alert signals during the test shall constitute failing performance.

8.12 Facepiece Carbon Dioxide Content Test.

8.12.1 Application. This test shall apply to all SCBA facepieces.

8.12.2 Specimens. Each SCBA facepiece model and size shall be tested.

8.12.3 Specimen Preparation. Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), with an RH of 50 percent, ±25 percent.

8.12.4 Procedure. Specimens shall be tested as specified in Section 8.14 of EN 136, *Respiratory protective devices — Full face masks — Requirements, testing, marking*.

8.12.5 Report. The facepiece carbon dioxide content shall be recorded and reported for each test specimen.

8.12.6 Interpretation.

8.12.6.1 The facepiece carbon dioxide content shall be used to determine pass/fail performance.

8.12.6.2 One or more specimens failing this test shall constitute failing performance.

8.13 EOSTI Independent Activation Test.

8.13.1 Application. This test method shall apply to complete SCBA.

8.13.2 Samples. Samples for testing shall be selected as specified in 4.3.5.

8.13.3 Specimen Preparation. Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), at an RH of 50 percent, ±25 percent.

8.13.4 Apparatus.

8.13.4.1 Testing shall be performed using a calibrated pressure gauge accurate to within ±0.25 percent of full span and graduated in increments of 0.5 bar (7½ psi) or smaller.

8.13.4.2 A bleed valve capable of bleeding pressure at a rate not exceeding 50 bar (750 psi) per minute shall be used.

8.13.4.3 An adapter shall be provided to connect the calibrated pressure gauge and bleed valve to the SCBA breathing air cylinder connection.

8.13.5 Procedure.

8.13.5.1 Each SCBA test specimen shall be modified so that all EOSTI sensing mechanisms, other than the one being tested, are blocked to simulate failure.

8.13.5.2 SCBA test specimens shall be tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), at an RH of 50 percent, ±25 percent.

FAIR USE

8.13.5.3 The adapter to connect the calibrated pressure gauge and bleed valve shall be installed at the breathing air cylinder connection on the SCBA test specimen.

8.13.5.4 After pressurizing the SCBA test specimen breathing air cylinder to greater than 30 percent of cylinder rated service pressure, the pressure shall be bled to ambient pressure at a rate not greater than 50 bar (750 psi) per minute.

8.13.5.5 The EOSTI alarm signal from the unblocked EOSTI shall function as specified in 7.13.1.

8.13.5.6 This test shall be repeated for each EOSTI.

8.13.6 Report.

8.13.6.1 The activation of the EOSTI alarm signal and the breathing air cylinder pressure at which the alarm signal activates shall be recorded and reported.

8.13.6.2 The breathing air cylinder pressure at which the EOSTI alarm signal stops shall be recorded and reported.

8.13.6.3 The proper functioning of the EOSTI alarm signal as specified in 7.13.1 shall be recorded and reported.

8.13.7 Interpretation.

8.13.7.1 The proper activation and continued operation to the specified pressure shall be used to determine pass/fail performance.

8.13.7.2 One or more specimens failing this test shall constitute failing performance.

8.14 EOSTI Recognition Test.

8.14.1 Application. This test method shall apply to complete SCBA.

8.14.2 Samples. Samples for testing shall be selected as specified in 4.3.5.

8.14.3 Specimen Preparation. Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), at an RH of 50 percent, ±25 percent.

8.14.4 Apparatus.

8.14.4.1 An adapter shall be provided that allows the person conducting the test to manually switch between a breathing air supply greater than 30 percent of the SCBA breathing air cylinder rated service pressure to a breathing air supply pressure of 18 bar, ±1 bar (265 psi, ±15 psi).

8.14.4.2 Each SCBA test specimen shall be tested separately by two individual test subjects.

8.14.4.3 Test subjects shall wear full structural fire-fighting protective ensemble, including coat, trousers, helmet, hood, gloves, and footwear, that is certified as compliant with NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*.

8.14.4.4 Testing shall be performed with test subjects walking at 5 km/hr, ±0.2 km/hr (3 mph, ±0.12 mph) on a treadmill at zero percent grade.

8.14.4.5 Testing shall be conducted in a test chamber that absorbs a minimum of 90 percent of all sound from 500 Hz to 5000 Hz.

8.14.4.6 Test subjects shall have "audiometrically normal" hearing as defined in Section 5.3 of ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems*, in the range of 500 Hz to 3000 Hz.

8.14.4.7 Test subjects shall have had a physical examination conducted by a physician within the past 12 months of the date of testing.

8.14.4.8 The treadmill shall be positioned in the test chamber specified in 8.14.4.5 in a location where the conditions for background noise, lighting, and distraction specified in 8.14.4.9 and 8.14.4.10 are met.

8.14.4.9 The test chamber shall be filled with "pink" noise with a tolerance of 6 dB per octave band from 400 Hz to 4000 Hz and shall be adjusted to achieve an A-weighted sound level of 75 dB, ±2 dB measured at each ear of the test subject when the subject is walking on the treadmill as specified in 8.14.4.4.

8.14.4.9.1 The forward axis of the loudspeaker shall be located as far as possible from, and pointed away from, the test subject so as to create a quasi-uniform sound field at the test subject's ears.

8.14.4.9.2 More than one loudspeaker shall be permitted to be used to achieve the desired sound level.

8.14.4.10 The area in the test chamber where the test subject's head is positioned when standing in the walking location on the treadmill shall be artificially lighted to achieve a light level of between 100 lux and 500 lux.

8.14.4.11 A reading stand containing printed text shall be positioned relative to the treadmill as follows:

(1) The vertical center of the text shall be in line with the center of the treadmill track within ±100 mm (4 in.).
(2) The horizontal center of the text shall be at the same height, ±100 mm (4 in.), as the eye level of the test subject when the subject is standing in the walking position on the treadmill.
(3) The text shall be at a distance from the test subject that permits the text to be read by the subject while walking on the treadmill.

8.14.5 Procedure.

8.14.5.1* Each specimen to be tested shall be an SCBA modified such that all EOSTI sensing mechanisms other than the one being tested are blocked so as to simulate failure.

8.14.5.2 Prior to testing, the special adapter specified in 8.14.4.1 shall be installed at the breathing air cylinder connection on the SCBA specimen and the cylinder replaced with the air source specified in 8.14.4.1.

8.14.5.3 Each SCBA test specimen shall be modified so that all EOSTI sensing mechanisms, other than the one being tested, are blocked to simulate failure.

8.14.5.4 SCBA test specimens shall be tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), at an RH of 50 percent, ±25 percent.

8.14.5.5 A test subject wearing the protective ensemble specified in 8.14.4.3 shall don the test specimen SCBA and begin walking on the treadmill in the ambient conditions specified in 8.14.4.9 and 8.14.4.10.

8.14.5.6 While breathing from the SCBA, the test subject shall read aloud the printed text.

FAIR USE

8.14.5.7 The person conducting the testing shall switch from the breathing air supply at greater than 30 percent of cylinder rated service pressure to 18 bar, ±1 bar (265 psi, ±15 psi) at a random point between 30 seconds and 120 seconds from the commencement of the test.

8.14.5.8 The test subject shall acknowledge recognition of the alarm signal immediately upon becoming aware of it by a gesture that has been predetermined between the test subject and the person performing the testing.

8.14.5.9 The test shall be repeated by the second test subject.

8.14.6 Report. The time elapsed between the switch to low supply air pressure and the acknowledgement of recognition of the EOSTI alarm signal by the test subject shall be recorded and reported.

8.14.7 Interpretation. Failure of either of the two test subjects to acknowledge recognition of the EOSTI alarm signal within the time period specified in 7.13.2 shall constitute failing performance.

8.15 HUD Wiring Connection Strength Test.

8.15.1 Application. This test method shall apply to SCBA facepieces with HUD and any associated assemblies with interconnecting wiring.

8.15.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.15.3 Specimen Preparation.

8.15.3.1 Specimens for conditioning shall be SCBA facepieces with HUD and any associated assemblies with interconnecting wiring.

8.15.3.2 Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), RH of 50 percent, ±25 percent.

8.15.4 Apparatus. A mass of known weight with the means for attachment to wiring shall be provided.

8.15.5 Procedure. A force of 156 N, ±9 N (35 lbf, ±2 lbf) shall be applied gradually, in an axial direction, to the wiring of the specimen being tested.

8.15.6 Report. Observations of the HUD functionality shall be recorded and reported.

8.15.7 Interpretation. Observation of HUD functionality in accordance with 6.3.5 shall be used to determine pass/fail performance.

8.16 HUD Low-Battery Visual Alert Signal Test.

8.16.1 Application. This test shall apply to all HUD low-battery visual alert signals.

8.16.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.16.3 Specimen Preparation. Specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), RH of 50 percent, ±25 percent.

8.16.4 Apparatus. A variable power supply that is capable of supplying dc voltage of at least 30 percent more than the nominal battery pack voltage shall be provided.

8.16.5 Procedure.

8.16.5.1 Each HUD shall be tested with a variable power supply to determine that the low-battery visual alert signal will activate at the voltage, ±3 percent, that is specified by the manufacturer.

8.16.5.2 Each HUD shall be tested with a variable power supply to determine that the HUD will continue to display the visual information and visual alert signals down to the cease-proper operation voltage, ±3 percent, that is specified by the manufacturer.

8.16.5.3 Each HUD battery pack shall be tested by discharging it at the nominal operating current specified by the manufacturer until the voltage falls to the level at which the HUD low-battery visual alert signal will illuminate as specified in 6.3.8.6.

8.16.5.4 Upon reaching this voltage, the current drain shall be increased to the peak current drain of the battery pack specified by the manufacturer for all systems supplied by this battery pack. Under these conditions and for a period of at least two hours, the battery voltage shall remain above the voltage that will cause the HUD to cease proper operation.

8.16.6 Report.

8.16.6.1 HUD shall be observed for activation of the low-battery visual alert signal.

8.16.6.2 HUD shall be observed for the display of the visual information and visual alert signals down to the cease-proper-operation voltage.

8.16.6.3 The battery pack voltage shall be observed with respect to the cease-proper-operation voltage.

8.16.6.4 The events in 8.16.6.1 through 8.16.6.3 shall be recorded and reported.

8.16.7 Interpretation.

8.16.7.1 HUD low-battery visual alert signal function shall be evaluated to determine pass/fail.

8.16.7.2 HUD battery pack voltage greater than or equal to the cease-proper-operation voltage shall constitute pass.

8.17 HUD Liquid Splash Resistance Test.

8.17.1 Application. This test method shall apply to complete SCBA.

8.17.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.17.3 Specimen Preparation.

8.17.3.1 Specimens for conditioning shall be complete SCBA.

8.17.3.2 Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), RH of 50 percent, ±25 percent.

8.17.4 Apparatus. The apparatus and supplies for testing shall be those specified in ASTM F 1359, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*, with the following modifications:

(1) The mannequin used in testing shall be fully upright and shall have straight arms and legs with the arms positioned at the mannequin's side.
(2) The surface tension of the water used in testing shall be 35 dynes/cm, +5 dynes/cm.

FAIR USE

8.17.5 Procedure.

8.17.5.1 The SCBA, with a fully charged breathing air cylinder, facepiece with HUD assembly, and any associated electronic assemblies shall be placed on the mannequin to simulate its typical wearing position as specified by the manufacturer. The SCBA facepiece shall be secured to the head of the mannequin in such a manner as to assure a watertight seal.

8.17.5.2 The mannequin shall be mounted upright and placed inside the liquid spray chamber. The mannequin shall then be exposed to the liquid spray for a period of 60 minutes, 15 minutes in each of the four mannequin orientations as specified in ASTM F 1359, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin.*

8.17.5.3 The liquid shall be sprayed at a rate of 3 L/min, ±0.2 L/min (48 gal/hr, ±3 gal/hr) through each nozzle simultaneously.

8.17.5.4 At the end of the liquid spray period, excess liquid shall be removed from the surface of the specimen SCBA facepiece with HUD and any associated electronic assemblies.

8.17.5.5 Specimen SCBA with HUD and any associated electronic assemblies shall be removed from the liquid spray chamber, and testing shall begin within 10 minutes of removal from conditioning.

8.17.5.6 Specimen SCBA with HUD and any associated electronic assemblies shall be operated in accordance with the manufacturer's instructions to determine the proper functioning as specified in 7.14.3.

8.17.5.7 The battery compartment(s) of specimen SCBA with HUD shall be opened, and each HUD battery compartment shall be inspected for water leakage to determine pass/fail.

8.17.6 Report.

8.17.6.1 Observations of proper function for each specimen shall be recorded and reported after the performance procedure.

8.17.6.2 Observations of water inside the battery compartment(s) after the performance procedure shall be recorded and reported.

8.17.7 Interpretation. Pass/fail performance shall be determined for each specimen. One or more specimens failing this test shall constitute failing performance.

FAIR USE

8.18 HUD Visibility Test.

8.18.1 Darkness Test.

8.18.1.1 Application. This test method shall apply to complete SCBA.

8.18.1.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.18.1.3 Specimen Preparation. Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), with an RH of 50 percent, ±25 percent.

8.18.1.4 Apparatus.

8.18.1.4.1 The SCBA breathing air cylinder shall be permitted to be replaced with a cylinder of lesser capacity. The breathing air capacity of the replacement cylinder shall be greater than 200 L (7.1 ft^3).

8.18.1.4.2 Testing shall be performed in a light-controlled enclosure, designated as the "testing enclosure." A diffused light source that provides a luminance of 2 lux, ±1 lux, shall be used to illuminate across the surface of the SCBA facepiece lens.

8.18.1.5 Procedure.

8.18.1.5.1 The selected test subjects shall have visual acuity of 20/20 in each eye uncorrected or corrected with contact lenses. Selected test subjects shall be able to read lower case letters measuring 2.5 mm (3⁄32 in.) in height at a distance of 305 mm (12 in.).

8.18.1.5.2 The test subject shall don a complete SCBA.

8.18.1.5.3 The test subject shall enter the testing enclosure and be positioned so that the SCBA facepiece is illuminated as specified in 8.18.1.4.2.

8.18.1.5.4 The test subject shall wait 1 minute to allow the eyes to acclimate to the illumination.

8.18.1.5.5 The SCBA shall be activated so as to activate the HUD.

8.18.1.5.6 The cylinder shall be fully charged and the HUD shall show full cylinder charge.

8.18.1.5.7 The SCBA pressure shall be slowly decreased so as to activate all HUD visual displays.

8.18.1.6 Report.

8.18.1.6.1 Each visual display of information and each visual alert signal as defined by the manufacturer's instructions shall be observed and shall be distinct and identifiable.

8.18.1.6.2 The test subject's observations shall be recorded and reported.

8.18.1.7 Interpretation. The test subject's ability to distinguish between each visual display of information and each visual alert signal as defined by the manufacturer's instructions shall be observed and the distinguishing features shall be distinct and identifiable.

8.18.2 Light Test.

8.18.2.1 Application. This test method shall apply to complete SCBA.

8.18.2.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.18.2.3 Specimen Preparation. Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, +5°F), with an RH of 50 percent, ±25 percent.

8.18.2.4 Apparatus.

8.18.2.4.1 The SCBA breathing air cylinder shall be permitted to be replaced with a cylinder of lesser capacity. The breathing air capacity of the replacement cylinder shall be greater than 200 L (7.1 ft^3).

8.18.2.4.2 Testing shall be performed in a light-controlled enclosure, designated as the "testing enclosure." A diffused light source that provides a luminance of 10,000 lux, ±1000 lux, shall be used to illuminate across the surface of the SCBA facepiece lens.

8.18.2.5 Procedure.

8.18.2.5.1 The selected test subjects shall have visual acuity of 20/20 in each eye uncorrected or corrected with contact lenses. Selected test subjects shall be able to read lower case letters measuring 2.5 mm ($\frac{3}{32}$ in.) in height at a distance of 305 mm (12 in.).

8.18.2.5.2 The test subject shall don a complete SCBA.

8.18.2.5.3 The test subject shall enter the testing enclosure and be positioned so that the SCBA facepiece is illuminated as specified in 8.18.2.4.2.

8.18.2.5.4 The test subject shall wait 1 minute to allow the eyes to acclimate to the illumination.

8.18.2.5.5 The SCBA shall be activated so as to activate the HUD.

8.18.2.5.6 The cylinder shall be fully charged and the HUD shall show full cylinder charge.

8.18.2.5.7 The SCBA pressure shall be slowly decreased so as to activate all HUD visual displays.

8.18.2.6 Report.

8.18.2.6.1 Each visual display of information and each visual alert signal as defined by the manufacturer's instructions shall be observed and shall be distinct and identifiable.

8.18.2.6.2 The test subject's observations shall be recorded and reported.

8.18.2.7 Interpretation. The test subject's ability to distinguish between each visual display of information and each visual alert signal as defined by the manufacturer's instructions shall be observed and distinguishing features shall be distinct and identifiable.

8.19 HUD Obscuration Test.

8.19.1 Application. This test method shall apply to complete SCBA where there is a gap greater than 1 mm ($\frac{1}{32}$ in.) between the HUD and the exterior surface of the SCBA facepiece lens.

8.19.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.19.3 Specimen Preparation. Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), with an RH of 50 percent, ±25 percent.

FAIR USE

8.19.4 Apparatus.

8.19.4.1 Each test specimen to be tested shall be an SCBA with the facepiece modified by the application of a light-reducing film to the entire outer lens surface of the facepiece. The film shall exclude 94.5 percent to 95.5 percent of visible light.

8.19.4.2 The SCBA breathing air cylinder shall be permitted to be replaced with a cylinder of lesser capacity. The breathing air capacity of the replacement cylinder shall be greater than 200 L (7.1 ft^3).

8.19.4.3 Testing shall be performed in a light-controlled enclosure, designated as the "testing enclosure." A diffuse light source that provides a luminance of 20 lux, +0 lux or –5 lux, shall be used to illuminate across the surface of the SCBA facepiece lens.

8.19.5 Procedure.

8.19.5.1 The selected test subjects shall have visual acuity of 20/20 in each eye uncorrected or corrected with contact lenses.

8.19.5.2 The test subject shall don a complete SCBA.

8.19.5.3 The test subject shall enter the testing enclosure and be positioned so that the SCBA facepiece is illuminated as specified 8.19.4.3.

8.19.5.4 The test subject shall wait at least 1 minute to allow the eyes to acclimate to the illumination.

8.19.5.5 The SCBA shall be activated so as to activate the HUD.

8.19.5.6 The SCBA pressure shall be slowly decreased until the breathing air supply in the cylinder is exhausted.

8.19.6 Report.

8.19.6.1 The test subject shall report which informational displays and visual alert signals were observed.

8.19.6.2 The test subject's observations shall be recorded and reported.

8.19.7 Interpretation. The test subject's observations shall be compared to the manufacturer's specified informational displays and visual alert signal to determine pass/fail.

8.20 HUD Disabling Glare Test.

8.20.1 Application. This test method shall apply to complete SCBA.

8.20.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.20.3 Specimen Preparation. Prior to testing, test specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), with an RH of 50 percent, ±25 percent.

8.20.4 Apparatus.

8.20.4.1 Testing shall be performed in a light-controlled enclosure, designated as the "testing enclosure," with a diffused light source that provides a luminance of 2 lux, +0/–1 lux, measured at the surface of the reading text card.

8.20.4.2 At least 8 text cards for reading shall be provided. Each text card shall have 10 different randomly selected letters of 2.5 mm ($\frac{3}{32}$ in.) in height printed in lower case on the card.

8.20.4.3 The SCBA breathing air cylinder shall be permitted to be replaced with a cylinder of lesser capacity. The breathing air capacity of the replacement cylinder shall be greater than 200 L (7.1 ft^3).

8.20.5 Procedure.

8.20.5.1 The selected test subjects shall have visual acuity of 20/20 in each eye uncorrected or corrected with contact lenses. Selected test subjects shall be able to read lowercase letters measuring 2.5 mm ($\frac{3}{32}$ in.) in height at a distance of 305 mm (12 in.).

8.20.5.2 The test subject shall enter the testing enclosure that is illuminated as specified in 8.20.4.1.

8.20.5.3 The test subject shall wait at least 1 minute to allow the eyes to acclimate to the illumination.

8.20.5.4 A text card as specified in 8.20.4.2 shall be used for each before-reading procedure and each after-reading procedure of a single test.

8.20.5.5 Different text cards as specified in 8.20.4.2 shall be used for each test.

8.20.5.6 With the test subject's vision blocked, the text card shall be placed in a fixed position inside the testing enclosure at a distance of 305 mm, +0/mm or –25 mm (12 in., +0 in. or –1 in.), from the test subject's face.

8.20.5.7 For the "before-reading" portion of the test procedure, the test subject shall read out loud the 10 letters on the text card.

8.20.5.8 The test subject shall then don a complete SCBA.

8.20.5.9 The SCBA shall be activated so as to activate the HUD.

8.20.5.10 With the test subject's vision blocked, a different text card shall be placed in a fixed position inside the testing enclosure at a distance of 305 mm, +0/mm or –25 mm (12 in., +0 in. or –1 in.), from the test subject's SCBA facepiece lens.

8.20.5.11 The SCBA cylinder pressure shall then be slowly decreased until the breathing air supply in the cylinder is exhausted.

8.20.5.12 The "after-reading" portion of the test procedure shall be conducted while the cylinder pressure is being slowly decreased. The test subject shall read out loud the 10 letters on the text card.

8.20.6 Report.

8.20.6.1 The test subject's visual acuity as required in 8.20.5.1 shall be recorded and reported.

8.20.6.2 The test subject's ability to read the lowercase letters as required in 8.20.5.1 shall be recorded and reported.

8.20.6.3 The test subject's reading of the 10 letters in the "before-reading" portion of the test as required in 8.20.5.7 shall be recorded and reported for each letter.

8.20.6.4 The test subject's reading of the 10 letters in the "after-reading" portion of the test as required in 8.20.5.12 shall be recorded and reported for each letter.

8.20.7 Interpretation.

8.20.7.1 The test subject's inability to read at least 9 of the 10 "before-reading" letters shall constitute failing performance.

8.20.7.2 The test subject's inability to read at least 9 of the 10 "after-reading" letters shall constitute failing performance.

8.21 Cylinder Refill Breathing Performance Test.

8.21.1 Application. This test method shall apply to complete SCBA.

8.21.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.21.3 Specimen Preparation. Prior to testing, test specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) at an RH of 50 percent, ±25 percent.

8.21.4 Apparatus.

8.21.4.1 The test apparatus shall be as specified in 8.1.4.

8.21.4.2 An RIC UAC filling hose assembly shall be provided.

8.21.4.3 The breathing air source shall provide a constant pressure equal to the rated service pressure of the SCBA breathing air cylinder, +0 bar or –6.8 bar (+0 psig or –100 psig).

8.21.5 Procedure.

8.21.5.1 The SCBA shall be tested for air flow performance as specified in 8.1.5, with the modification that the test will begin with the SCBA breathing air cylinder pressurized to 25 percent of the rated pressure.

8.21.5.2 The RIC UAC filling hose shall be connected to the constant pressure source.

8.21.5.3 At 10 cycles, ±5 cycles, of the breathing machine, the RIC UAC female fitting on the RIC filling hose shall be connected to the RIC UAC male fitting on the SCBA. The RIC UAC coupling shall remain connected until the air transfer is completed.

8.21.5.4 The duration of the air flow performance test shall end 4 minutes after the air transfer has commenced per 8.21.5.3.

8.21.6 Report. The facepiece peak inhalation and exhalation pressure shall be recorded and reported.

8.21.7 Interpretation. The peak inhalation and peak exhalation pressures shall be used to determine pass/fail.

8.22 RIC UAC System Fill Rate Performance.

8.22.1 Application. This test method shall apply to complete SCBA.

8.22.2 Samples. Each sample to be tested shall be as specified in 4.3.5.

8.22.3 Specimen Preparation. Prior to testing, the specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) at an RH of 50 percent, ±25 percent.

8.22.4 Apparatus.

8.22.4.1 An RIC UAC filling hose assembly shall be provided.

8.22.4.2 The air source shall provide a constant pressure equal to the rated service pressure of the SCBA cylinder, +0 bar/–6.8 bar (+0 psig/–100 psig).

8.22.4.3 Testing shall be performed using a timer capable of measuring elapsed time within the range of 0 to 5 minutes.

8.22.5 Procedure.

8.22.5.1 The pressure of the SCBA breathing air cylinder shall be 0 bar (0 psig).

8.22.5.2 The RIC UAC filling hose shall be connected to the constant pressure air source.

8.22.5.3 With the SCBA breathing air cylinder valve fully open, the RIC UAC filling hose shall be connected to the RIC UAC male fitting.

8.22.5.4 The test timer shall begin when the RIC UAC filling hose is connected to the SCBA.

8.22.5.5 The pressure in the SCBA breathing air cylinder shall be monitored.

8.22.5.6 When the pressure in the SCBA breathing air cylinder reaches 75 percent of the rated service pressure of the SCBA cylinder, the test timer shall be stopped.

8.22.6 Report. The elapsed time shall be observed, recorded, and reported.

8.22.7 Interpretation. The elapsed fill time shall be used to determine pass/fail.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 The use of SCBA by fire fighters is always assumed to be in atmospheres immediately dangerous to life or health (IDLH). There is no way to predetermine hazardous conditions, concentrations of toxic materials, or percentages of oxygen in air in a fire environment, during overhaul (salvage) operations, or under other emergency conditions involving spills or releases of hazardous materials. Thus, SCBA are required at all times during any fire-fighting, hazardous materials, or overhaul operations. General use criteria are contained in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program.*

A.1.2.3 Although SCBA that meet this standard have been tested to more stringent requirements than required for NIOSH certification, there is no inherent guarantee against SCBA failure or fire fighter injury. Even the best-designed SCBA cannot compensate for either abuse or the lack of a respirator training and maintenance program. The severity of these tests should not encourage or condone abuse of SCBA in the field.

The environmental tests utilized in this standard alone might not simulate actual field conditions, but are devised to put extreme loads on SCBA in an accurate and reproducible manner by test laboratories. However, the selection of the environmental tests was based on summary values derived from studies of conditions that relate to field use.

FAIR USE

A.1.2.4 To help guide the purchase of SCBAs, refer to NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA).*

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.11 Combination SCBA/SAR. This definition does not include SARs that are used in conjunction with an escape self-contained breathing apparatus (ESCBA) where the ESCBA provides less than a minimum rated service time of 30 minutes. For the purposes of this standard, combination SCBA/SARs are encompassed by the term SCBA.

A.3.3.14 Compressed Breathing Air. The quality of the compressed breathing air used in open-circuit SCBA has a direct effect on the performance of this equipment. It is therefore imperative that a breathing air be used that is consistent with the design criteria established in this standard to ensure that the SCBA will continue to meet the performance criteria contained in this standard. It has been established through years of experience that Grade D breathing air with a maximum moisture content of 24 ppm or drier [that is, a dew point of −65°F (−54°C) or lower] and a maximum particulate level of 5 mg/m^3 air will meet the needs of both the fire fighter and the SCBA. *(See also 8.1.3.3.)*

A.3.3.29 NIOSH Certified. An SCBA being "NIOSH certified" is only one part of the certification process to NFPA 1981. SCBA that are only NIOSH certified are not compliant with NFPA 1981 and should not be construed as having certification as compliant with NFPA 1981. See Section 4.1 for further details. For the NIOSH certification to remain in effect, the SCBA must be used and maintained in the "as approved" condition.

A.3.3.34 Product Label. This product label is not the certification organization's label, symbol, or identifying mark; however, the certification organization's label, symbol, or identifying mark may be attached to it or be part of it.

A.4.1.2.2 SCBA that are certified by NIOSH include a rated service time based on laboratory tests required by NIOSH. The SCBA is tested using a specified breathing machine with a breathing rate of 40 L/min. NIOSH uses this 40 L/min rate because it represents a moderate work rate that an average user can sustain for a period of time. To attain a rated service time of 30 minutes during this 40 L/min test, the typical SCBA cylinder must contain 1200 L or more of compressed breathable air. A 45 ft^3 cylinder has a capacity of 1273.5 L, based on 28.3 L/ft^3. Because actual work performed by a fire fighter often results in a ventilation rate that exceeds 40 L/min, fire fighters will frequently not attain the rated service time of 30 minutes. During extreme exertion, for example, actual service time can be reduced by 50 percent or more.

To ensure proper utilization of equipment in actual situations, after training and instruction, it is recommended that users gain confidence by actually using the SCBA in a series of tasks representing or approximating the physical demands likely to be encountered.

In addition to the degree of user exertion, other factors that can affect the service time of the SCBA include the following:

(1) The physical condition of the user *(see also ANSI Z88.6, Respiratory Protection — Respirator Use — Physical Qualifications for Personnel)*
(2) Emotional conditions such as fear or excitement, which can increase the user's breathing rate
(3) The degree of training or experience the user has had with such equipment
(4) Whether or not the cylinder is fully charged at the beginning of use
(5) The facepiece fit
(6) Use in a pressurized tunnel or caisson [At two atmospheres of pressure (29.4 psig), the duration will be one-half the duration obtained at one atmosphere of pressure (14.7 psig); at three atmospheres of pressure (44.1 psig), the duration will be one-third the duration obtained at one atmosphere of pressure.]
(7) The condition of the SCBA
(8) The SCBA effective dead air space (Dead air space is a volume proportional to the CO_2 concentration in the inhaled breathing gas.)

During normal breathing without a facepiece, carbon dioxide, which is produced by the body's metabolism, is released to the environment with each breath. The facepiece of an SCBA reduces this environment to a small space around the face. On exhalation, a portion of the carbon dioxide–rich exhaled breath is trapped in this space. On inhalation, fresh air from the SCBA cylinder mixes with this carbon dioxide–rich air and then enters the lungs. The concentration of carbon dioxide is dependent on facepiece configuration, flow characteristics, and ventilation rate.

The full effect of increased dead air space has not been demonstrated. However, the scientific work done in this area shows that an increase of CO_2 in the inhalation air leads to increased ventilation and, consequently, shorter service time for a given air supply. Means to reduce CO_2 in the inhalation air by using, for example, a well-fitting nose cup have been demonstrated to give longer service time. Contact each manufacturer for specific data.

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A.4.2.1 The certification organization should have sufficient breadth of interest and activity so that the loss or award of a specific business contract would not be a determining factor in the financial well-being of the agency.

A.4.2.5 The contractual provisions covering certification programs should contain clauses advising the manufacturer that if requirements change, the product should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently listed products.

Without these clauses, certifiers would not be able to move quickly to protect their name, marks, or reputation. A product safety certification program would be deficient without these contractual provisions and the administrative means to back them up.

A.4.2.6 Investigative procedures are important elements of an effective and meaningful product safety certification program. A preliminary review should be carried out on products submitted to the agency before any major testing is undertaken.

A.4.2.9 Such inspections should include, in most instances, witnessing of production tests. With certain products the certification organization inspectors should select samples from the production line and submit them to the main laboratory for countercheck testing. With other products, it might be desirable to purchase samples in the open market for test purposes.

A.4.3 The testing facility should take suitable precautions to protect testing personnel and to guard against catastrophic failure that could result in a high-pressure gas release, fragmentation, and flying parts and debris. Catastrophic failure can occur because many tests specified in Chapter 8 involve compressed gas cylinders containing high pressures, and the tests are rigorous in nature.

A.4.6.1 ISO/IEC Guide 27 is a component of accreditation of certification organizations specified in 4.1.4 and 4.2.3 of this standard. Those paragraphs contain mandatory reference to ISO/IEC 65 in which ISO/IEC Guide 27 is referenced.

A.4.6.2 By definition, a hazard might involve a condition that can be imminently dangerous to the end user. With this thought in mind, the investigation should be started immediately and completed in as timely manner as is appropriate considering the particulars of the hazard being investigated.

A.4.6.11 The determination of the appropriate corrective action for the certification organization to initiate should take into consideration the severity of the product hazard and its potential consequences to the safety and health of end users. The scope of testing and evaluation should consider, among other things, testing to the requirements of the standard to which the product was listed as compliant; the age, type of use, and conditions to which the compliant product has been exposed; care and maintenance that has been provided; the use of expertise on technical matters outside the certification organization's area of competence; and product hazards caused by circumstances not anticipated by the requirements of the applicable standard. As a guideline for determining between a safety alert and a product recall, the following product hazard characteristics are provided. These characteristics are based on 42 CFR 84, Subpart E, §84.41:

Critical: A product hazard that judgment and experience indicate is likely to result in a condition immediately hazardous to life or health (IHLH) for individuals using or depending on the compliant product.

If an IHLH condition occurs, the user will sustain, or will be *likely* to sustain, an injury of a severity that could result in loss of life, or resultant significant bodily injury or loss of bodily function, either immediately or at some point in the future.

Major A: A product hazard, other than *Critical*, that is likely to result in failure to the degree that the compliant product does not provide any protection or reduces protection, *and is not detectable to the user.*

The term "reduces protection" means the failure of specific protective design(s) or feature(s) that results in degradation of protection in advance of reasonable life expectancy to the point that continued use of the product is *likely* to cause physical harm to the user, or where continued degradation could lead to IHLH conditions.

Major B: A product hazard, other than *Critical* or *Major A*, that is likely to result in reduced protection, and is detectable to the user.

The term "reduces protection" means the failure of specific protective design(s) or feature(s) that results in degradation of protection in advance of reasonable life expectancy to the point that continued use of the product is *likely* to cause physical harm to the user, or where continued degradation could lead to IHLH conditions.

Minor: A product hazard, other than *Critical, Major A*, or *Major B,* that is not likely to materially reduce the usability of the compliant product for its intended purpose, or a product hazard that is a departure from the established applicable standard and has little bearing on the effective use or operation of the compliant product for its intended purpose.

Where the facts are conclusive, based on characteristics of the hazard classified as indicated above, the certification organization should consider initiating the following corrective actions with the authorized and responsible parties:

(1) *Critical product hazard characteristics:* product recall
(2) *Major A product hazard characteristics:* product recall or safety alert, depending on the nature of the specific product hazard
(3) *Major B product hazard characteristics:* safety alert or no action, depending on the nature of the specific product hazard
(4) *Minor product hazard characteristic:* no action

A.4.6.13 Reports, proposals, and proposed TIAs should be addressed to the technical committee that is responsible for the applicable standard and be sent in care of Standards Administration, NFPA, 1 Batterymarch Park, Quincy, MA 02269-9101.

A.5.2.7 Users should be aware that NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, requires that all SCBA be air flow tested at least annually in accordance with the manufacturer's instructions. This interval of testing might not be adequate when SCBA are more frequently used. It is recommended that air flow testing be based on the number of SCBA uses rather than based solely on time intervals.

A.7.1 The current NIOSH certification test method, 42 CFR 84, uses a ventilation rate of 40 L/min, while NFPA 1981 requires an air flow test based on a ventilation rate of 100 L/min. A ventilation rate of 100 standard L/min encompasses the 98th percentile of all fire fighters studied. The ability of the SCBA to supply the 100 L/min of breathing gas is measured in this air flow performance test by monitoring the pressure within the facepiece.

Specific response times for both the pressure transducer and recorder are specified in this standard. It is important to note that if other types of recording devices, measuring equipment, and testing methods are used, pressure fluctuations might appear in the facepiece as short (millisecond) negative pressure spikes. The significance of these spikes to the actual protection afforded the user by the SCBA is not fully understood at this time. Additional studies are needed to determine the significance, if any, of these spikes. Because these negative spikes might affect the actual protection offered by the SCBA, it is recommended that a facepiece fitting program be established.

Quantitative fitting tests are recognized to be the best method for determining the facepiece-to-face seal and should be performed by the fire service wherever SCBA are used. For departments that wish to perform quantitative fit testing, a suggested procedure for conducting such tests can be found in ANSI Z88.2, *Practices for Respiratory Protection*.

A.7.9 This standard contains an abrasion test that is used to evaluate the outside surface of the facepiece lens. This standard does not address the abrasion resistance of the interior surface of the facepiece lens. Current facepiece lens interior surfaces can be uncoated, coated with an antifog agent, coated with an abrasion-resistant agent that does not comply with the performance required in Section 7.9, or coated with an abrasion-resistant coating that does comply with the performance required in Section 7.9. Information regarding coatings on the lens interior surface should be obtained from the SCBA manufacturer.

A.7.10 The communications test requires human subjects, there were variations in the data used to determine the appropriate pass/fail criteria. Therefore, a statistical approach to analyze the data was required to determine whether an individual SCBA meets the pass/fail criteria of Section 7.10. A null hypothesis test utilizing the Student *t*-distribution is the appropriate method to do this.

The Student *t*-distribution of 2.13 results from the following conditions:

Degrees of freedom = 4

Confidence level = 95 percent

Refer to any current statistical text for further information.

A.8.1.3.3 See A.3.3.14, Compressed Breathing Air.

A.8.1.5.1 The following is the calibration procedure for a breathing machine:

(1) *Equipment set up.* With the breathing machine stopped, connect a spirometer (Collins Medical model 06031 or equivalent) to the mouth of the head form such that an airtight connection is made. Indication of an airtight connection should be interpreted as an imperceptible change in indicated spirometer volume over a 30 second period.
(2) *Volume measurement at 100 L/min rate.*
    (a) Select the "Breathe at 100 L/min Rate" on the breathing machine control panel.
    (b) Measure the tidal volume of the breathing machine bellows by reading the spirometer.
    (c) Verify volume measured (V_m) to be 3.4 L, ±0.1 L.
    (d) Select "stop" on the breathing machine control panel.
(3) *Volume measurement at 40 L/min rate.*
    (a) Select "Breathe at 40 L/min Rate" on the breathing machine control panel.
    (b) Measure the tidal volume of the breathing machine bellows by reading the spirometer.
    (c) Verify volume measured (V_m) to be 1.67 L, ±0.1 L.
    (d) Select "stop" on the breathing machine control panel.
(4) *Adjustments.*
    (a) If the volume measured (V_m) is between 3.3 L and 3.5 L for the 100 L/min breathing rate and between 1.57 L and 1.77 L for the 40 L/min breathing rate, then the breathing machine is ready to conduct NFPA Air Flow Performance testing.
    (b) If the volume measured (V_m) is not between 3.3 L and 3.5 L for the 100 L/min breathing rate and not between 1.57 and 1.77 L for the 40 L/min breathing rate, then the breathing machine must be adjusted appropriately and the (V_m) remeasured before conducting NFPA Air Flow Performance testing.

A.8.3.4.5 See Annex B for surrogate cylinder preparation.

A.8.8.4.5 A means for doing this is by use of a properly calibrated smoke meter and standard light source.

A.8.8.4.7 Silica flour could present a health hazard. When using silica flour, ensure that the chamber is functioning properly and not leaking.

A.8.11 Complete engineering drawings to construct the heat and flame test apparatus can be obtained from NFPA.

A.8.11.4.2 The protective covering has been selected solely for the purpose of protecting the Flame and Heat Test mannequin and providing a reproducible exterior configuration to support the SCBA being tested. The intention of this standard is to test the SCBA and not the protective covering.

A.8.14.5.1 It is not the intention of this paragraph to require manufacturers to supply a separate modified SCBA for each EOSTI to be tested. In practice, it could be simpler to provide one SCBA with instructions to the testing laboratory on how to block each sensing device. The laboratory would block out all EOSTI except one and perform the test. After completion of one test, the laboratory would block the unblocked EOSTI and remove the block from another, repeating until each indicator has been tested.

Annex B Surrogate Cylinder Preparation Procedure

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Recommended Procedure for Surrogate Cylinder Preparation. Terms used in the procedure are as follows:

(1) Free-Air Volume (V): The amount of air in cubic feet at standard atmospheric conditions stored in the cylinder
(2) Water Volume (WV): Internal volume of the test cylinder determined by calculating water displacement
(3) Rated Storage Pressure (P): The nominal storage pressure rating of the cylinder at room temperature

B.2 Determining Mass of Air Stored in Cylinder (M). The following formula is used to determine M:

$$M = 0.0748V$$

where:
M = mass of air in cylinder (lbm)
V = free-air volume (ft^3)

B.3 Determining Nominal Design Weight (W). Weight can be estimated based on the following components:

$$W = W_1 + W_2 + M$$

where:
M = mass of air in cylinder (lbm)
W_1 = tare weight of empty cylinder less cylinder valve
W_2 = weight of cylinder valve assembly

B.4 Determining Ballast Rod Length (L). The ballast rod length is determined by measuring the overall length from the neck of the cylinder to the center of the bottom of the cylinder (L_1). The threaded engagement of the cylinder valve is also measured (L_2).

The overall length is calculated as follows (dimensions are shown in Figure 8.3.4.7):

$$L = L_1 - L_2 + 0.32 \text{ in.}$$

Note that it is important to ensure that the ballast rod does not extend beyond the cylinder.

B.5 Determining the Nominal Diameter of the Ballast Rod (D). The nominal diameter of the ballast rod is calculated as follows:

$$D = 2.060\sqrt{\frac{(M - 0.00318)V_2}{L}}$$

where:
M = air mass in cylinder (lbm)
V_2 = air volume in cylinder (in.^{3})
L = ballast rod length (in.)

$$V_2 = \frac{14.7V}{(P + 14.7)17.28}$$

where:
V = free-air volume of cylinder (ft^3)
P = rated storage pressure

B.6 Determining the Necessary Foam Weight (WF). This is found by subtracting the ballast rod weight from the total air storage weight as follows:

$$WF = (M - 0.2388)(D^2)L$$

where:
M = air mass in cylinder (lbm)
D = nominal diameter of ballast rod (in.)
L = ballast rod length (in.)

The foam should have a molded density of 5.5 lbf/ft^3 and mixed in a 50 percent ratio based on weight.

Theoretical amount of each component can be determined as follows:

$$\text{Weight of Component A} = \frac{WF}{2}$$

$$\text{Weight of Component B} = \frac{WF}{2}$$

The final recommended mixture for each component, measured in grams, is as follows:

$$\text{Component A} = 272\,WF\,(\text{g})$$

$$\text{Component B} = 272\,WF\,(\text{g})$$

B.7 Cylinder Preparation. Empty the cylinder of air and fully open the cylinder valve. Remove the cylinder valve from the cylinder. A means of threading the ballast rod to the cylinder valve must be incorporated. This procedure is most readily implemented by removing the “dip-tube” from the cylinder valve and adding a ⅜-16-UNC female thread on the end of the cylinder valve mounting thread.

B.8 Ballast Rod Machining. The ballast rod is machined from ASTM B 16 brass (hard). The machining details are provided in Figure 8.3.4.7. Care should be taken to ensure that the rod does not interfere with the cylinder at the valve end. This

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might require machining a short thread relief at the cylinder valve end of the ballast rod, which is indicated in Figure 8.3.4.7.

B.9 Cylinder Foam Filling. Once the cylinder valve has been installed and the ballast rod has been installed and torqued, the cylinder should be positioned vertically with the fill/vent holes pointing upwards. Commercially available plastic disposable laboratory funnels should be placed in the two fill/vent holes. Upon measuring the Component A and Component B materials, they should be simultaneously poured into the cylinder via the funnels.

Once the material has been poured into the cylinder, the funnels should be removed. The mixture can be agitated by shaking the cylinder. The foam will begin to rise in 40 to 50 seconds. The entire volume of the cylinder will fill and excess foam will vent out of the two fill holes. This material should be removed from the external surface of the cylinder.

B.10 Comparison of Total Mass of Surrogate Cylinder to Submitted Cylinder. The fully pressurized cylinder submitted for testing and the completed surrogate cylinder should be weighed separately. The weight of the surrogate cylinder cannot vary from the weight of the pressurized cylinder, which was submitted for testing, by more than 5 percent.

Annex C Informational References

C.1 Referenced Publications. The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

C.1.1 NFPA Publication. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* 2002 edition.

NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA),* 2002 edition.

C.1.2 Other Publications.

C.1.2.1 ANSI Publications. American National Standards Institute, 11 West 42nd Street, 13th floor New York, NY 10036.

ANSI Z88.2, *Practices for Respiratory Protection,* 1992.

ANSI Z88.6, *Respiratory Protection — Respirator Use — Physical Qualifications for Personnel,* 1984.

C.1.2.2 ISO Publications. International Standards Organization, 1 rue de Varembé, Case Postale 56, CH-1211 Genéve 20, Switzerland.

ISO/IEC Guide 27, *Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity,* 1983.

ISO/IEC 65, *General requirements for bodies operating product certification systems,* 1996.

ISO 9001, *Quality management systems — requirements,* 1999.

C.1.2.3 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 42, *Code of Federal Regulations,* Part 84, "Respiratory Protective Devices, Tests for Permissibility," 8 June 1995.

C.2 Informational References. (Reserved)

C.3 References for Extracts. (Reserved)

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